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UTAH SCIENCE

AGRICULTURAL EXPERIMENT STATION • JUNE 1968 • Vol. 29 No. 2

It is well known that honey bees, **Apis mellifera** L., visit alfalfa (lucerne), **Medicago sativa** L., more frequently for nectar than for pollen and that when they visit it for nectar, they pollinate only a small percentage of the flowers. Also sharply different percentages of alfalfa pollen are often brought into hives placed side by side in an apiary. Although this difference indicated that a genetic basis for such difference might exist, no tests were made until 1963, when daughters of queens taken from colonies collecting large and small amounts of alfalfa pollen were tested for heritability of this characteristic.

The steady progress in separating inbred lines that rank high and low as collectors of alfalfa pollen through six generations of selections, and the complete separation of the two lines proves that the tendency to collect alfalfa pollen is heritable.

Since pollen collectors are much more efficient than nectar collectors in tripping and cross-pollinating alfalfa flowers and since increased cross pollination benefits seed production, the greater value of a high pollen collection line for alfalfa seed production seems inescapable. For more detailed information, read "Breeding Bees to the Crop" in this issue of **Utah Science.**

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UTAH SCIENCE

A quarterly devoted to research in agriculture, land and water resources, home and community life, human nutrition and development, and published by the Agricultural Experiment Station, Utah State University, Logan, Utah.

The magazine will be sent free on request.

To avoid overuse of technical terms, trade names of products or equipment sometimes are used. No endorsement of specific products or firms named is intended, nor is criticism implied of those not mentioned.

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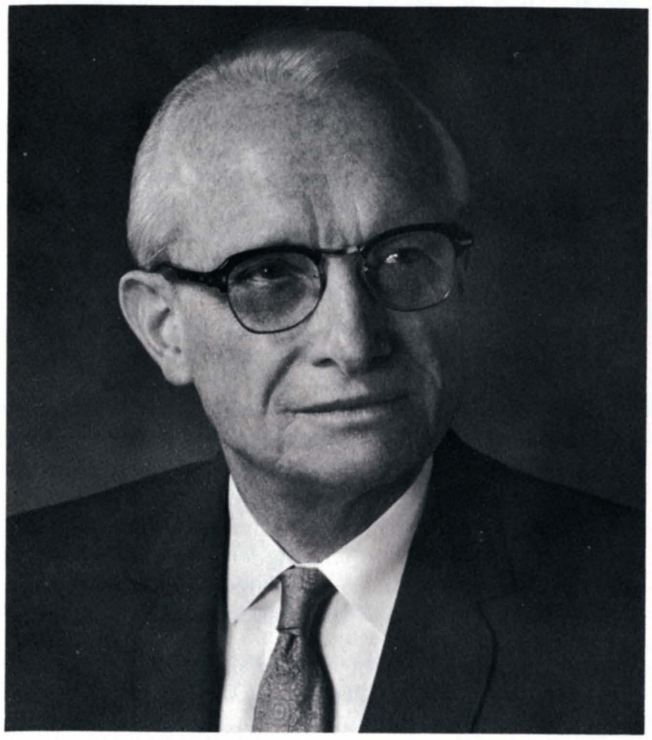
Agricultural Experiment Station

Millard E. Wilde, Editor

UTAH STATE UNIVERSITY . . .

President Chase Retires June 30



PRESIDENT DARYL CHASE

The United States has found itself in a fortunate situation in recent decades. It has not only produced an abundance of food and fiber for its own people, but has been able to share its surplus with hungry nations. This fortunate position has been the result of applied agricultural science and technology.

Today there is an increasingly compelling need to find the means of meeting the dilemma of continuing population growth in the world and the threat of widespread starvation and malnutrition.

Agricultural scientists from Utah State University have made significant contributions to America's abundance and to meeting world food problems as they have served the agriculture of Utah. As a state research agency, the Utah Agricultural Experiment Station has a long record of service. Scientists of the Station developed disease resistant wheat varieties to assure the state's wheat industry and new livestock strains to increase growers' profits. They have performed research to grapple with pollution problems and develop the recreation and tourist potential — to name only a few.

It has become apparent that Americans cannot supply all the world's food needs, even with the abundance of its own production. Thus thoughtful men have concluded that the developing nations must increase their own productivity. Through technical advisory missions in Iran, Latin American and other areas, Utah scientists have made significant contributions to the ability of developing peoples to increase their own capability. In the past decade, Experiment Station staff members have visited every continent of the earth to assist underdeveloped countries in solving their agricultural problems, to foster international good will, and to bring home ideas and varieties to improve Utah agriculture.

Reporting research results and making new knowledge available to other scientists and other potential users is vital to successful development. Utah Science has played a major role in the diffusion of knowledge. Since the inception of the magazine under direction of Director R. H. Walker and the editorship of the late Mrs. Gladys Harrison in 1940, it has served the Experiment Station, the university and the citizens of Utah. Subsequent directors and editors have built well on the solid base laid down by the founders. In its 28 years of service, Utah Science has published 114 issues with some 1,200 articles on vital topics. It has been widely acclaimed for its comprehensive and effective coverage. As my term of office comes to a close, I wish to add my commendation and congratulations to all associated with Utah Science for the great service it performs.

Grazing vs. wheat production on marginal Utah cropland

JOHN P. WORKMAN and JACK F. HOOPER

Many acres of marginal dry farm cropland in Utah have been converted from wheat production to a permanent cover of drought tolerant perennial grasses under the Conservation Reserve Program (Soil Bank) which was initiated in 1956. Much of this land has recently been released from retirement and the remainder of the soil bank contracts will expire by 1970. Farmers who volunteered for the land retirement program are now faced with the decision whether, in order to maximize benefits, to leave the released land in permanent cover for grazing purposes or to return the land to wheat production.

INFORMATION NEED

A minimum amount of information is currently available to aid farmers, ranchers, and federal agency personnel in making rational decisions concerning optimum use of marginal cropland. To provide the needed information and guidelines, a Utah State University study was initiated July 1, 1967. The major objective of the study is to secure information by soil type and/or range site concerning: (1) potential livestock or wheat production; (2) costs of livestock production by size of operation; (3) costs of wheat production by size of operation; and (4) break-even prices of livestock and wheat by size of operation.

The study was initiated by determining potentials for usable forage production and wheat production on different sites in the Curlew Junction area of northern Utah. Per acre costs and returns for forage production and wheat production were synthesized for the average 600-acre farm in this area. Budget analysis revealed that in terms of pure economic return, forage production enterprises had a definite advantage over wheat production enterprises (tables 1 and 2). Both enterprises yielded a pure economic loss. This means that when all costs including implicit costs (opportunity costs which are not "out of pocket") were subtracted from total revenue, both enterprises showed a loss.

THE SMALLER LOSS

From a basic economic standpoint, the problem in this case is one of choosing the enterprise showing the smaller loss. However, the difference between cash receipts and cash costs (return to implicit costs) was greater with wheat production than with forage production. Many farmers and ranchers do not subtract the costs of self labor, interest on investment, and depreciation on machinery and improvements from total revenue. It appears, then, that farmers allocating their land resources to wheat production would enjoy a higher standard of living than would their neighbors involved in forage production.

Another factor which should be considered from the standpoint of society are the costs of soil and water losses. If soil and water losses are greater with cropping, these losses should also be charged to

Figure 1. Termination of Soil Bank contracts has presented farmers with the problem of choosing between wheat production (left) and forage production (right).

JOHN P. WORKMAN is an NDEA Fellow in the Department of Range Science. JACK F. HOOPER is an Assistant Professor in the same Department.

wheat production. This aspect of the comparison of cropping and grazing is also being investigated.

Under the assumption of the synthesized budgets and other things equal a farmer would maximize net return to implicit costs by producing wheat on his land unless: (1) grazing fees increase to $10.99 per animal unit month (AUM); (2) forage yields increase to 3.14 AUMs per acre (2,826 pounds usable forage); (3) cash costs of producing wheat rise to $19.79 per acre; (4) wheat prices drop to $1.16 per bushel; and (5) wheat yield drops to 6.8 bushels per acre.

NEXT PHASE

During the next phase of this study, the emphasis will be placed on securing information of the type shown in tables 1 and 2 for various soil types and range classifications. We will obtain a breakdown of cost and return data with regard to the various existing scales (sizes) of operation in both wheat and forage producing enterprises. The relationship between wheat production and forage production will be obtained on each soil type or range site. This relationship will permit the conversion of potential wheat production into potential forage production and *vice versa*. Comparisons of costs and returns to wheat and forage production can then be made on various sites and at various scales of operation.

Two wheat production alternatives will be compared for different sizes of operations. The alternatives are owner-operator and share-rent. Three forage production alternatives in addition to leasing forage on an AUM basis will be considered. They are: (1) leasing forage to stockmen on a pounds of livestock gain basis; (2) purchase of stocker cattle by the land owner. and (3) use of forage to replace purchased feed where the land owner already runs livestock.

In summary, the study will provide information from which recommendations can eventually be made to farmers and ranchers concerning the optimum employment of their land resources. Findings will also be

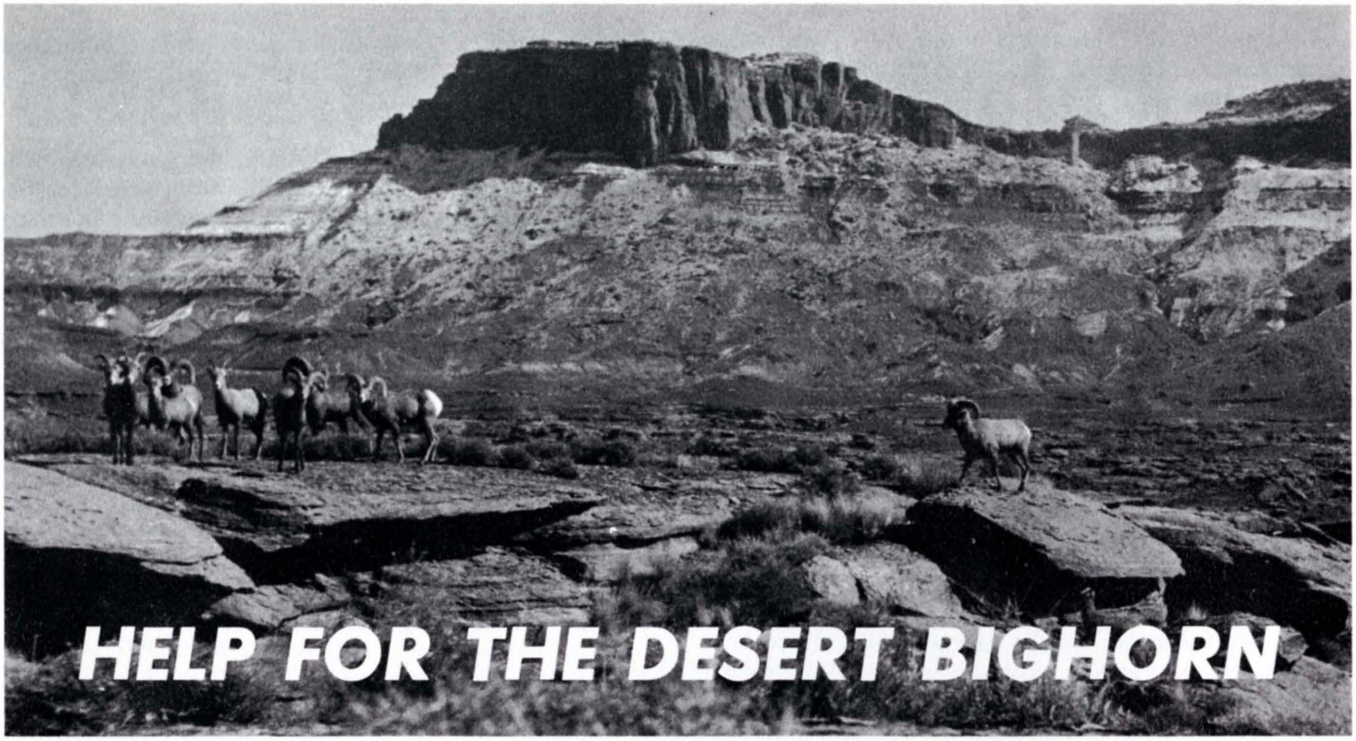
(Continued on page 60)

Table 1. Forage production costs, returns and investment (per acre)

Per acre costs:		
Fence and water repairs	$ 1.25	
Interest on operating capital	.20	
Total variable cash costs	1.45	
Operator labor .26 hr. @$1.50	.39	
Total variable implicit costs	.39	
Total variable costs		$1.84
Taxes	1.60	
Total fixed cash costs	1.60	
Depreciation on fences and water (10 years)	.56	
Interest on investment (5%)	3.28	
Total fixed implicit costs	3.84	
Total fixed costs		5.44
Total per acre costs		7.28
Per acre returns (grazing fee for 1 AUM or 900 usable lbs. forage)[1]		3.50
Net return (pure economic return)		— 3.78
Net return to capital		— .50
Net return to capital and operator labor		— .11
Net return to implicit costs (capital, operator labor, depreciation)		.45
Per acre investment		
Land	60.00	
Fences and water development	5.55	
Total per acre investment	$65.55	

[1] It was assumed that the land owner leased crested wheatgrass forage growing on former cropland to stockmen at a rate of $3.50 per AUM.

Figure 2. Ignoring machinery depreciation (and other implicit costs), wheat production provided a higher return above cash cost than forage production.



HELP FOR THE DESERT BIGHORN

LANNY WILSON, LARRY FARNSWORTH, and LOIS M. COX

The rugged canyon country of southeastern Utah still harbors some of the most prized game animals on the North American continent. But their numbers have been depleted since Father Escalante wrote (perhaps imprecisely) of wild sheep "in such abundance that their tracks are like those of great flocks of domestic sheep." That was in 1776. Today, the desert bighorn sheep is rare along the Green and Colorado Rivers.

Pushed off their ranges by domestic stock, suddenly subjected to diseases carried by domestic sheep, and often wantonly killed, the desert bighorn could only retreat. Then the discovery of uranium along the Colorado in southeastern Utah led to an almost complete decimation of the sheep during the 1950s. But the miners who sought relaxation and food by hunting the bighorn also inadvertently generated interest among people who may succeed in fostering an expanded population.

THE FIRST LICENSED HUNT

In June 1965 a study was begun through Utah's Division of Fish and Game and the Utah Cooperative Wildlife Research Unit at Utah State University. The major objectives included determining whether the bighorn sheep in southeastern Utah were desert or mountain bighorns, and the present numbers and distribution of the animals. The condition of the range and any factors that might be limiting the bighorn population were also to be studied.

The investigator, a USU graduate student, spent 270 days in the field between June 6, 1965 and November 21, 1966. Working within the White Canyon area west of Blanding, Utah, he acquired significant information about the sheep.

For one thing, it was decided that the Utah sheep were desert, rather than mountain bighorns. In fact, largely based upon his data, Utah was able to offer 10 individuals a chance to hunt this magnificent trophy animal in 1967. Nine of the 10 "once in a lifetime" permit holders went into the field. And, although limited to shooting only trophy rams 7 years old or older, all nine were successful. Prior to Utah's 1967 hunt, the desert bighorn could be hunted only in Nevada, New Mexico, Arizona, and Mexico.

The 1965-66 study accomplished far more than a census justifying a limited hunt, however. It provided badly needed insights into the sheep's way of living and the factors most crucial to their survival.

LANNY WILSON is a Wildlife Biologist in the Bureau of Land Management, Burley, Idaho. LARRY FARNSWORTH is a Conservation Officer with the Utah Fish and Game Division. LOIS M. COX is Technical Writer for the Utah Agricultural Experiment Station and the Division of University Research.

GRAZING HABITS AND COMPETING FORAGERS

Apparently the desert bighorn sheep does little or no damage to its range unless circumstances such as limited access to water force over-use of a given area. Since the sheep generally keep on the move while grazing, only a few bites are taken

from each plant. The exceptions are large shrubs, and a sheep may spend several minutes eating from one shrub. When given a choice, the sheep seemed to prefer galleta grass and blackbrush over the other forage plants around White Canyon.

In addition to the expected grazing and browsing, the USU student occasionally observed adult ewes digging for some sort of root or bulb. But he was unable to determine what specific type of plant they were after.

The domestic cattle currently grazed in the White Canyon area compete very little with the desert bighorns. Cattle simply can't navigate over terrain that the bighorns traverse with ease. Mule deer, however, generally provide significant grazing competition from October through March. The sheep do not seem inclined to argue with the deer, but instead, just retreat to smaller and/or less desirable areas as the deer move in.

But neither competition for food nor predation (primarily by bobcats) is the main deterent to expanding Utah's population of desert bighorn sheep. The 1965-66 study made it clear that water supplies set the range (and therefore population) boundaries. Mineral deficiencies also are believed to be a factor in limiting any population expansion, but without more water in more places, on a year-round basis, the White Canyon bighorn sheep are not likely to increase substantially in number.

NEED FOR MINERALS

During the 1965-1966 study, the sheep were often observed eating clay in certain parts of their range. One old ewe carried a deer antler with her as she grazed during the day. She would nibble the antler periodically and while leaving it for a short time to graze a given area, she'd return for it when ready to move any substantial distance.

Deliberately placed salt blocks went unused by the Utah sheep. An inclosed band of desert bighorns in Texas, however, made ample use of a salt containing protein, minerals, Vitamin A and an antibiotic. While having access to this salt, the Texas bighorn sheep had a higher than usual reproduction rate and no lamb deaths were noted.

The severe lamb losses (49 per cent in 1 year in Utah, an average of 50 per cent on the Desert Game Range in Nevada) among desert bighorns may be indirectly due to mineral deficiencies. The Utah study indicated no major problem with intestinal parasites, but a high susceptibility to pneumonia. Such susceptibility would naturally occur in malnourished animals. The combination of a mineral deficiency plus the restricted range areas caused by lack of water would particularly stress very young and very old individuals.

TO GET A DRINK OF WATER

Most of the sheep in the area live on or around 7,000-foot Wingate Mesa, which encompasses an area of about 75 square miles. All of Wingate Mesa and its canyons, however, contain only 11 year-round water holes. During the dry season (April through July or so) and sometimes for virtually the whole year, the bighorns can therefore occupy less than 15 of the 75 square miles. The same small percentage of occupancy probably holds throughout the Desert Bighorn's range in Southeastern Utah.

During his 270 days in the field, the USU graduate student was able to map present and potential watering spots. He chose locations for future development on the basis of several criteria, one of the most important being ease of access for bighorns but not for domestic stock.

His recommendations for developing a total of 35 watering sites are currently being considered by the Bureau of Land Management and the Utah State Division of Fish and Game. If funded and implemented, the increased access to water would allow the sheep to graze the entire Wingate Mesa instead of just the few square miles now being overgrazed. The additional water sites would also benefit other wildlife (such as chukars, doves, and deer) in the area. Water hole development also might give the ewes a wider choice among acceptable alternatives for their yearly lambing grounds.

The recommended work takes advantage of existing seeps and springs

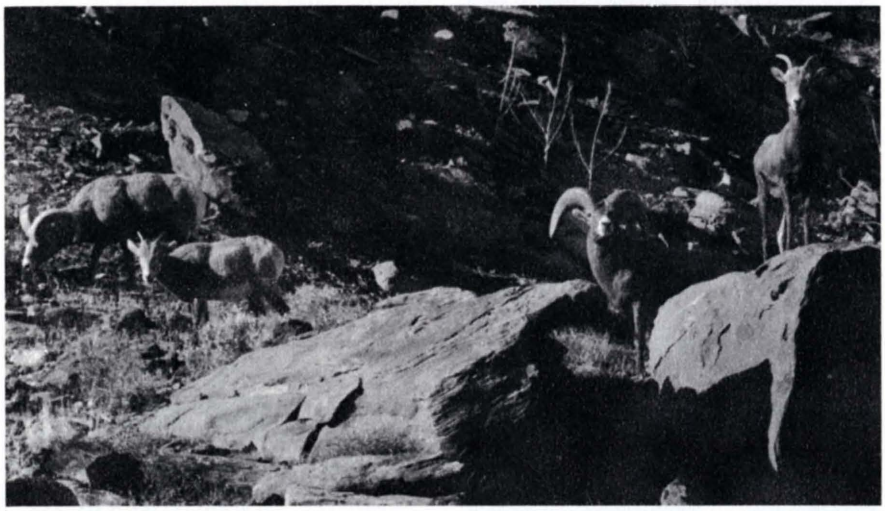


Figure 1. These desert bighorns exist in the canyon country of southeastern Utah between Escalante and Blanding. They traverse this rugged terrain with ease, something range cattle are hard-put to do. The chief limiting factor to the bighorns' increase is the lack of year-round water supplies evenly distributed throughout the White Canyon-Wingate Mesa area.

whenever possible. In some cases, however, it may be necessary to install precipitation-catchment devices (guzzlers). Eradication of cottonwood trees in some locations might materially increase the amounts of water available at the soil surface. Since the sheep apparently will travel only 10 to 15 miles in search of water, water-hole development must be carefully preplanned and systematic.

Along with the water project, the agencies responsible for managing the area are considering chaining and reseeding approximately 6,000 acres on top of Wingate Mesa. If this is done, and deer can be discouraged from grazing the reseeded land, the desert bighorns would be materially aided. In effect, presently unusable and unused land could thus be made to support a highly valued animal population.

Figure 3. This bighorn ewe has just sensed the presence of the photographer.

HUNTING POTENTIALS

Utah's desert bighorn sheep could become an increasingly significant asset to the state. Relatively small investments now, would provide substantial returns in the future as the herd expands.

Instead of allowing only severely restricted hunts, Utah could eventually capitalize upon the widespread desire for a desert bighorn trophy. The regular harvesting of rams 7 or 8 years old and older would not only satisfy trophy hunters, it could conceivably benefit the herd. Once the sheep have adequate water and nutritional resources, reproductive rates might be further enhanced by a yearly removal of the older, perhaps less fertile rams.

If uranium mining in the area becomes active again, a conservation officer may have to be assigned to the area to discourage illegal hunting. Some of the watering sites might also need regular servicing. But in general, an initial investment now can be expected to return benefits for a long time, with minimal "upkeep" costs.

PROTECT your FORESTS, WILDLIFE, and FISH in the interest of conservation, timber resources, and recreation values so vital to individual well-being and national progress.

PNEUMONIA DRUGS FIGHT SOME PLANT DISEASES

Antibiotics that cure a type of pneumonia in human beings will also cure a serious disease of vegetables, U.S. Department of Agriculture research shows.

In tests with thousands of plants at Beltsville, Md., scientists of USDA's Agricultural Research Service found that well-known antibiotic drugs such as chlortetracycline, tetracycline, and chloramphenicol are very effective in combating aster yellows, a serious disease of many plants including tomatoes, potatoes, carrots, celery and onions. Aster yellows causes severe stunting, yellowing, and flower sterility, and eventually destroys the plant.

The tests were conducted by Drs. Robert E. Davis, virologist, Robert F. Whitcomb, entomologist, and Russell L. Steere, botanist, of the ARS Pioneering Laboratory for Plant Virology. Their findings have raised the hope that presently known antibiotics may be used effectively in the battle against aster yellows and similar diseases of food crops and ornamental plants.

Work done by Japanese scientists on a mulberry disease led ARS scientists to suspect that certain plant diseases, long thought to be caused by viruses, are really caused by 'Mycoplasma-like" organisms similar to those responsible for diseases in man and warm blooded animals. Following up this lead, the scientists ran tests on the aster yellows plant disease and found that it could indeed be cured by the same antibiotics used to treat diseases of man.

Plants showing severe disease symptoms, when treated with an effective antibiotic, produced new, healthy leaves and flowers. When the plants were taken off the drugs, the symptoms reappeared 3 or 4 weeks later.

ASSESSING FARM LAND ACCORDING TO ITS VALUE FOR AGRICULTURAL USE

RONDO A. CHRISTENSEN

When Utahns go to the polls in November they will find on the ballot a proposed constitutional amendment which would allow a change in the assessment of farm land for tax purposes. What is this amendment all about? Why has it been proposed? What does it seek to accomplish? Have other states similar constitutional provisions? Is it justified? What would be the economic effects on assessed values and tax levies? These questions are discussed in this and a subsequent article to be published in *Utah Science*.

THE PROPOSED AMENDMENT

The proposed amendment is being placed on the ballot in November in response to a resolution of the 1967 Utah Legislature. The resolution, S.J.R. 2, proposes to amend Article XIII, Section 3 of the Constitution of the state which deals with assessment and taxation procedures by adding the following sentence: "Land used for agricultural purposes may, as the Legislature prescribes, be assessed according to its value for agricultural use without regard to the value it may have for other purposes."

The proposed amendment is only permissive. Even if passed, before agricultural-use values could be legally used for assessing farm land, the Legislature would have to first enact a law specifying how and under what conditions they could be used, and indicate which lands would qualify for the differential assessment. Once the amendments were passed, however, the Legislature could not only authorize the use of agricultural-use values in assessing farm land, but could change the rules and regulations governing their use from time to time as they felt was in the public interest, without requiring subsequent changes in the Constitution.

THE PROBLEM

The rationale behind the proposed amendment is partially expressed in a statement made by Governor Calvin L. Rampton when he said that if the proposed amendment is not passed "there is a good chance farmers will be taxed out of business." His statement reflects a widely held belief that high taxes are responsible for the disappearance of agriculture from the fringe of many growing cities.

There are three reasons why this may be so. *One* is our continued heavy reliance on the property tax to finance public schools and local and county governments, and the heavy burden this places on farmers who, by the nature of their businesses, use large amounts of property in relation to the income they derive. Property taxes, for instance, currently make up 45 percent of total public school expenditures and about 40 percent of total tax revenues in the state.[2]

A *second* problem is the increasing mill levy on property to finance public services in the rural-urban fringe, sometimes referred to as the rurban area, where city and country meet, and where to some extent they are interdispersed. In these areas subdivisions adjacent to city boundaries often leap-frog here and there, leaving crop farms, dairies and orchards in between. This creates problems in water and sewer service, garbage collecting, police and fire protection, transporting children to school, plowing snow from streets, etc.

●

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Most of these services are demanded by rurban homeowners, just as though they were living in the city, but the cost of providing them is often higher. For instance, Salt Lake County had a 21-mill property tax levy in 1967 compared with only six mills for Utah County. One of the main reasons for the difference in the opinion of I. Dale Despain, Utah County planning consultant, is the regulations which Utah County has had for many years with regard to planning and zoning which encourage the development of subdivisions adjacent to city boundaries, thus allowing them to tie into existing city services.[3]

The *third* problem is related to the second, and has to do with the inflation of farm land values as cities expand, as subdivisions rise in the middle of farm land, and as speculators buy up farm and open land for investment purposes. Needless to say, when adjacent lands sell for building lots or for speculative purposes at increasingly higher prices, adjoining farm lands increase in fair cash value also, regardless of the fact they continue to be farmed and are worth no more for farm use. As fair cash values rise, according to present law, so should assessed values. In some cases they have risen proportionately, but in others farm lands have continued to be assessed on the basis of their value for agricultural use, or somewhere between agricultural-use value and the fair cash value for the best and highest value use.

The combination of these three phenomena — heavy reliance on the property tax to finance the costs of education and local governments, high mill levies, and high assessed values per acre in the rurban fringe — may have already placed more of a burden on some farmers than they

have been able to bear, forcing them to sell prematurely.

EFFECTS OF THE PROBLEM

The premature sale of farm land to subdividers and investors because of inability to pay the higher taxes encourages leap-frogging of subdivisions, and in some cases, inefficient use of land, particularly where it lies idle for a number of years while awaiting development. It also contributes to the breaking up of the "green belt" or "green strip" which would otherwise surround metropolitan areas. Some city and county planners are now trying to preserve such green belts for their aesthetic value, for their apparent contribution to human welfare and happiness, and for their recreational value.

While some farmers may feel the tax problem is already acute, it will become generally more so during the years ahead. Without the amendment, the Legislature presumably must continue to direct as stated in the Utah Code Annotated: "all taxable property, not specifically exempt under Article XIII, Section 2, of the Constitution of Utah, must be assessed at thirty per cent of its reasonable fair cash value. . . ." Since it is not exempt, this applies to all privately owned farm land, regardless of its location, use, or potential value for other purposes.

The State Tax Commission in its efforts to seek compliance with this law is requiring that the assessment of all real property throughout the state first be raised to and equalized at 20 percent of its fair cash value. The percent of fair cash value at which real property is currently assessed varies considerably by type of property and by location, both within and among counties. For instance, improved residential real estate is currently assessed at an average of 17.6 percent of fair cash value, improved commercial real estate at 19.1 percent, unimproved city and town lots at 11.4 percent, and parcels in excess of 3 acres (mostly farm land) at 10.2 percent, according to the State Tax Commission.

The farms hardest hit by assessing at a full 20 percent of fair cash value would be those in the more densely populated counties where fair cash values for farm land substantially exceed agricultural-use values because of the added location value of the land. In Weber County for example, assessed values will be trebled if they are raised to 20 percent of fair cash value, in Davis County they will be increased by 2.6 times, and in Salt Lake County they will be about doubled. On the other hand, in rural counties where farm land has little value for purposes other than farming, there probably will be little change. Farm land in counties such as Sanpete, Piute and Millard are already assessed at 20 percent or more of their fair cash value.[4]

Two parcels of farm land in Salt Lake County are used to illustrate how assessed values may change. One parcel, located in the Jordan area, has 40 acres. It is completely surrounded by other farm land and it is currently assessed at $80 per acre. The assessment would be raised to $200 per acre if the assessment were 20 percent of fair cash value, and would be lowered to $60 if the assessment were 20 percent of agricultural-use value. The other parcel is a 30 acre piece of land situated on the west side of Salt Lake City. It is flanked by other farm land on two sides and residential property on the other two sides. The current assessed value is $110 per acre. The assessment would be $560 per acre if it were 20 percent of fair cash value, and $60 if 20 percent of agricultural-use value.

SOLVING THE PROBLEM

State legislators in at least 23 other states have recognized the need to lighten the tax burden on farm land in rurban areas while at the same time exercising more control over urban expansion, and have attempted to do something about it. The general intent of most of the proposals considered is expressed in the following portion of a law[5] enacted in Maryland in 1960:

> . . . it being the intent of the General Assembly that the assessment of farm land shall be maintained at levels compatible with the continued use of such land for farming and shall not be adversely affected by neighboring land uses of a more intensive nature. The General Assembly hereby declares it to be in the general public interest that farming be fostered and encouraged in order to maintain a readily available source of food and dairy products close to the metropolitan areas of the State, to encourage the preservation of open space as an amenity necessary to human welfare and happiness, and to prevent the forced conversion of such open space to more intensive uses as a result of economic pressures caused by the assessment of land at a rate or level incompatible with the practical use of such land for farming.

Three general plans have been developed to ease the tax burden on farm land in rurban areas. They include: (1) differential assessment, (2) deferred or roll back tax, and (3) purchase of development rights. In each case the current assessment is based on the value of the farm land for agricultural use.

Not all efforts to enact one of these plans have been successful. In some states insufficient support has been developed to push such a bill through the legislature. In others, acts which were passed have been found to be in conflict with the state constitution and have been declared unconstitutional. In yet other states, proposed constitutional amendments to permit special assessment of farm land have been turned down by the public.

Nevertheless, the number of states that permit the assessment of farm land according to its agricultural-use value is increasing, whether by act of the legislature or by constitutional amendment and/or legislative act.

At least nine states presently have some form of differential assessment. They include Arkansas, California, Connecticut, Florida, Indiana, Iowa, Maryland, Minnesota and Oregon. The differential assessment plan provides for the assessment of farm land in relation to its present use, *i.e.,* agricultural use, even though nearby land may be devoted to a higher value use. Differential assessment is, in effect, an outright permanent tax abatement plan. The

amount of tax abatement is the difference between the tax on the farm land assessed according to its agricultural-use value versus its fair cash value. In addition to the above states which have legalized preferential assessment of farm land, others grant such treatment as a matter of common assessing practice. Such practice has been common and still is to a more or less extent in some of Utah's counties.

Three states — Hawaii, New Jersey and Oregon — presently have some form of deferred taxation. Under the deferred or roll back tax plan, farm land is assessed and taxed from year to year in relation to its value for agricultural use. At the same time however, the assessing officer also records on the assessment rolls the assessed value based on the fair cash value of the land. When the land is sold for, or converted to, a non-farm use, the seller or owner must pay the difference between the tax actually paid and the tax that would have been paid had the property been assessed and taxed in relation to its fair cash value. The number of years that taxes are rolled back upon the change in use may vary from 1 or 2 to as far back as when the taxes were first deferred. A rate of interest may or may not be required on the deferred taxes. The deferred tax plan is less a departure from the strict *ad valorem* basis of taxation, and, if taxes are rolled completely back, it does not involve a tax reduction or abatement, only a deferral.

Three states — Alabama, Connecticut, and Maryland — have some form of the plan where development rights are acquired from the owners of farm land by local governments. Under the plan the owner either gives or sells to the local governmental unit the rights to develop the land in exchange for the right to have his land assessed on the basis of its agricultural-use value. Under this plan the land is preserved in agricultural use, and as such helps to maintain open space, until the governmental unit decides that the time for development has arrived.

Each of these plans, to be effective in preserving open space, eliminating urban sprawl, and reducing the tax burden on farm land in rurban areas, needs to be tied to local zoning planning. For instance, differential assessment could be automatically used in assessing farm land in areas zoned as agricultural, while at the same time being prohibited or permitted only upon application or in special cases on farm land still remaining in residential, commercial, and industrial zones.

IS THE AMENDMENT JUSTIFIED?

Special handling of certain classes of property is not new. Household furnishings, furniture and equipment and all intangible property such as stocks and bonds are currently exempt from assessment and taxation in Utah. Under the "freeport law," goods destined for shipment outside the state are exempt from taxes for 1 year whether originating inside or outside of the state. Efforts are now under way to repeal the annual tax on all inventories, whether shipped out of state within a year or not. And needless to say, properties of the United States, Utah, counties, cities, towns, school districts, and religious and charitable institutions are also exempt.

The case for the amendment and appropriate subsequent legislation to assess farm land according to its agricultural value depends on the extent to which present assessment procedures and property tax levels are inequitable, and have, or will prematurely force land out of the hands of owner-operators and into hands of investors.

Following is a table which gives some indication of relative ability to pay and property tax burden between the population as a whole and farmers. Total property taxes charged in Utah as a percent of total personal income are compared with property taxes charged farmers as a percent of net farm income. Not all of the taxes charged are paid out of income since those that are charged on business property are deducted before arriving at total personal income and net farm income. While off-farm income by farmers has not

Table 1. Property taxes charged as a percent of income, Utah 1957-1967

Year	INCOME		PROPERTY TAXES CHARGED		Total property taxes in percent of personal income	Farm property taxes in percent of net farm income
	Total personal income*	Net farm income‡	On all property†	On farm property§		
	$ million	$ million	$ million	$ million	Percent	Percent
1957	1482	52.4	67.5	5.6	4.6	10.7
1958	1547	41.5	72.6	6.0	4.7	14.5
1959	1676	44.6	83.3	6.8	5.0	15.3
1960	1771	40.6	87.0	7.0	4.9	17.3
1961	1909	32.4	94.2	7.5	4.9	23.3
1962	2072	39.2	96.6	7.5	4.7	19.1
1963	2155	30.6	106.8	8.0	5.0	26.2
1964	2218	24.5	114.7	8.2	5.2	33.7
1965	2348	33.1	122.6	8.6	5.2	25.8
1966	2502	48.1	125.4	8.5	5.0	17.6
1967	2650	43.8	131.8	8.6	5.0	19.8
	Average				4.9	20.3

* Includes the sum of all income payments to individuals.

‡ Includes cash receipts from farm marketings, value of home consumption of farm products, rental value of farm dwellings and net changes in inventory, less production costs including taxes on all farm property except residences and personal motor vehicles.

† Includes residential, commercial and agricultural real estate and buildings; motor vehicles; commercial and agricultural machinery; merchandise and fixtures; livestock; utilities; and mine, oil and gas properties.

§ Includes rural farm residences and farm automobiles and trucks in addition to farm real estate, buildings, machinery and livestock.

Source: Statistical Review of Government in Utah, 1967, Utah Foundation; Statistical Study of Assessed Valuations, annual issues, State Tax Commission; Income From Farming, Utah, annual issues, Statistical Reporting Service.

been included, neither have property taxes on city residential property owned by farmers. Thus, while the data are not fully comparable, they still give some indication of levels and trends in income and property taxes charged.

Both total personal income and total taxes paid on property in Utah almost doubled between 1957 and 1967. Total property taxes charged as a percent of personal income varied from a low of 4.6 percent to a high of 5.2 percent, and averaged 4.9 percent.

On the other hand, while property taxes charged farmers have increased more than 50 percent since 1957, net farm income has decreased, varying considerably from year to year, but never rising as high as it was in 1957. As a result, farm property taxes as a percent of net farm income rose from 10.7 percent in 1957 to a high of 33.7 percent in 1964 when farm income was exceptionally low, and averaged about 20 percent during the 11-year period.

Another comparison of relative ability to pay and tax burden is shown in table 2. The table shows all Utah general sales, property, income, and Federal income taxes paid by individuals or paid by them in the operation of a farm or self employed business as a percent of income *before* taxes. The data are based on 5,810 returns from a random sample of 1963 Utah individual income tax returns on which deductions were itemized. The data are summarized by nine occupational groups. One can safely generalize from these data to all residents itemizing deductions, but not to all families in the state, since a greater proportion of the higher income families generally itemize deductions.

These data indicate that farmers, despite their lower than average income, pay a substantially higher proportion of their income before taxes for Utah sales, property and income taxes — 17.0 percent compared with an average of 6.5 percent for all occupational groups in 1963. The main reason for this is the high property tax burden they bear — 12.7 percent compared with an average of 3.2 percent. Sales taxes in percent of income before taxes are also high for farmers since they pay sales taxes on all farm purchases which are not for resale. in addition to on the items they buy for personal consumption.

While farmers paid a smaller share of their income for Utah income taxes, this did not begin to offset the higher sales and property taxes they paid. Even after combining the Federal income tax with the three Utah taxes, farmers still had the highest burden — 22.8 percent of income before taxes compared with an average of 17.0 percent for all occupational groups. The self-employed, whose incomes were almost double that of farmers, were second with 21.6 percent. All of the other occupational groups paid under 18 percent. Retired persons were lowest with 13.9 percent.

Some may contend that it is not appropriate to include in analyses such as this, sales and property taxes paid by the self employed and farmers on their business operations because of the possibility they may have of shifting these taxes to the consumers of their products and services.

While shifting these taxes remains a possibility, there is no evidence that farmers in Utah have been able to do this and achieve a higher than average income, while competing in the market place with farmers in other production areas. In fact, among individuals itemizing deductions in 1963, farmers had the lowest average income after taxes of all occupational groups, except for unskilled workers and retired people. Farmers averaged $4,409 per individual or family filing a Utah tax return compared with an average of $5,378 for all occupational groups. The self-employed were highest with $7,946 and retired people were lowest with $2,856.

Table 2. Selected taxes paid as a percent of income, by occupation groups, Utah, 1963

Occupation	Number of Returns	AVERAGE INCOME Before taxes*	AVERAGE INCOME After taxes‡	AVERAGE TAXES IN PERCENT OF INCOME (before taxes) General sales	Property	Utah income	Total Utah	Federal income	Total
Self-employed	274	$10,146	$7,946	2.2	4.7	1.5	8.4	13.2	21.6
Professional, salaried	1,281	8,341	6,883	2.0	2.5	1.2	5.7	11.7	17.4
Sales, clerical	1,169	5,422	4,538	2.1	2.5	1.0	5.6	10.6	16.2
Skilled workers	741	6,920	5,842	2.1	2.7	.9	5.7	9.8	15.5
Semi-skilled workers	1,110	6,292	5,329	2.4	2.6	.8	5.8	9.5	15.3
Unskilled workers	688	4,103	3,388	2.7	5.1	.8	8.6	8.8	17.4
Farmers	159	5,705	4,409	3.6	12.7	.7	17.0	5.8	22.8
Retired	143	3.318	2,856	2.1	4.6	1.2	7.9	6.0	13.9
Other	245	6,128	5,214	1.9	2.7	1.2	5.8	10.6	16.4
TOTAL	5,810	$ 6,475	$5,378	2.2	3.2	1.1	6.5	10.5	17.0

* Includes income before general sales, property and Utah and Federal income taxes from salaries and wages, interest, dividends and capital gains, and net income from unincorporated businesses, professions and farming operations.

‡ After Utah sales, property, income and Federal income taxes.

These data indicate that from a tax-burden and ability-to-pay point of view, some adjustments in our assessment and tax laws to lighten the tax burden on farmers can be justified. The passing and implementation of the proposed amendment to assess farm land in relation to its agricultural-use value, rather than some higher value use, would help in rurban areas. It would probably do little, however, to mitigate the generally high property tax burden carried by farmers throughout the state.

The impact of the proposed amendment on assessed values and taxes in Salt Lake County will be presented in the next issue of *Utah Science*.

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The Reluctant Jumpers

J. JUAN SPILLETT and LOIS M. COX

Pronghorn antelope can jump 8-foot barriers, but apparently they are unaware of their ability. This peculiarity was of no importance until sheep-tight fences became a fact of life on the range. Even so, it took the severe winter of 1948-49 to demonstrate the problem.

The pronghorn population in Wyoming and surrounding states suffered heavy losses that season. Both hunters and conservationists believed that fences had been a factor in these losses. Many people hypothesized that fences restricted antelope movement and thus kept them from finding shelter during storms.

The situation vaguely resembled the historical dispute over fences on the open range. This time, however, instead of drawing six-shooters, the people turned to research.

A fence-testing cooperative study involving personnel and financial support from Utah State University, various Wyoming groups (including the Wyoming Game and Fish Department, Wyoming sportsmen, private livestock organizations, and others), the U.S. Bureau of Land Management, and the Utah Cooperative Wildlife Research Unit began in 1963. Work that had been done earlier was used as a basis for designing the study.

THE SIZE OF THINGS

The pronghorn antelope is relatively small compared to other North American big game animals. An adult buck averages about 100 to 125 pounds and is rarely more than 38 inches at the shoulder. The larger adult does weigh about 100 pounds. They average 34 inches at the shoulder, which gives them an eye level of about 38 inches. When running, however, antelope generally extend their heads and necks, so the eye level is only slightly above shoulder height.

Their running style and their low eye-level height apparently contribute to their reluctance in fence

Figure 1. This circular trap corral of nylon rope net was used to catch the antelope used in the fence testing study.

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jumping. Almost invariably, antelope refused to jump fences over 32 inches high. Practically all the animals observed, routinely balked at jumping barriers that obstructed their view of conditions on the other side. The only exceptions to these general rules occurred when the antelope were under severe stress, such as close pursuit by human beings.

EARTH BOUND

As early as 1877 pronghorn antelope were reported to prefer crawling through or under fences to jumping them. According to a 1948 article, just 12 to 18 inches clearance allowed antelopes to pass under fences. This proclivity for crawling, rather than jumping, meant that the early cattle-type range fences gave antelope little trouble. Woven wire and sheep-proof fences, however, caused a different story.

Reports of investigations from New Mexico to Canada in the 1940s and 1950s agreed that while antelope could jump, they seldom did. Some of the observers also mentioned that antelope did seem to "learn" about fences. The antelope also did not seem hesitant about crossing cattle guards.

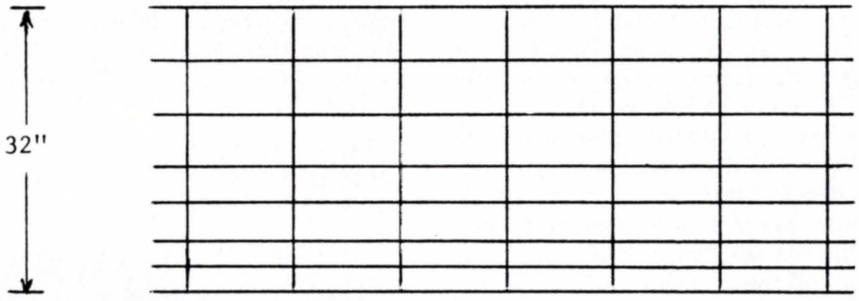

Figure 2. A net wire fence 32-inches high is sheep tight and the maximum that most antelope will readily cross.

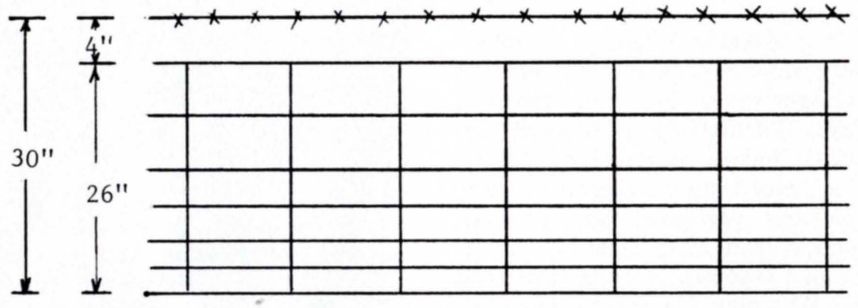

Figure 3. Antelope will also cross a fence of 26-inch net wire and one barbed wire 4 inches above. This fence also proved sheep tight.

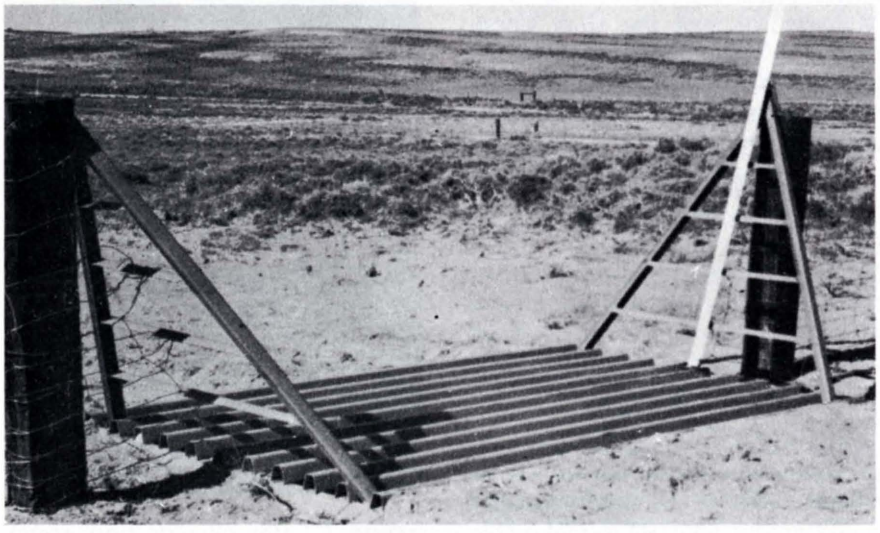

Figure 4. Standard cattle guards, if placed in corner locations, satisfactorily permit the movement of adult and yearling antelope yet retain sheep.

THE STUDY

To complete as meaningful a study as possible, the most recent work was done north of Wamsutter, Wyoming. The area provided antelope that had little previous contact with any fences. Water and feed were available within the study area, and the acreage was accessible year around. Actual trials were run from July 1963 through November 1964. Most of the fences tested with antelopes were later also tested in comparable ways with sheep.[1]

Of the 22 fence types tested, three offered the best possibilities for minimized interference with antelope movement while providing adequate sheep confinement. The three promising alternatives were, 32-inch wire net, 26-inch net with barbed wire 4 inches above, and standard cattle guards. Apparently corner locations for cattleguards mean that antelope can find them more easily and are more likely to use them.

The antelope will jump better than 7 feet horizontally in using cattleguards as a passageway, especially if the guards are located on or close to a regular route of travel.

An unexpected bonus from the Utah-Wyoming study is the realization that livestock men can have sheep-tight fences more cheaply than has been thought. Barbed wire is not essential and the fences do not have to be as high as once thought necessary.

[1] Spillett, J. Juan, Jessop B. Low, and David Sill. Livestock Fences — How They Influence Pronghorn Antelope Movements. Utah Agr. Exp. Sta. Bul 470. Dec. 1967.

Llama Reproduction- A South American Problem

WARREN C. FOOTE, BARRY G. ENGLAND, and MILLARD E. WILDE

The family *Camelidae* includes three genera., *Camelus* (camels), *Lama* (llamas, alpacas, and guanacos) and *Vicugna* (vicuna). The guanaco (*Lama guanicoe*) is a wild species and is considered to be the progenitor of the domestic llama (*Lama glama*) and alpaca (*Lama pacos*). The llama which is larger than the alpaca is used mainly for transportation while the alpaca is better adapted for fiber production.

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The smallest of the *Camelidae* family, the vicuna (*Vicugna Vicugna*) has an extremely valuable fiber. Excessive killing of these wild animals to facilitate harvesting their pelt has threatened their existence and they are now under governmental protection.

ECONOMICALLY IMPORTANT

The South American camel (*Camelidae*) plays an important part in the economy of the cordilleran countries of Argentina, Chile and especially Peru and Bolivia. These species, which are found from 10,000 to 16,000 feet elevation in the Andes Mountains provide a subsistence way of life for many Indians. They supply the highlanders with wool, milk, meat, and transportation. Peru has an estimated total of 2,720,000 cameloids; of these 2,000,000 are alpacas, 600,000 are llamas and 120,000 are vicunas. Bolivia has 1,780,000 llamas, 250,000 alpacas, and 50,000 vicunas. Argentina and Chile have significant but smaller numbers of these species.

A major part of the economy in the Andean areas of Bolivia and Peru depends upon these animals, not only for the high quality fiber which they produce, but also for meat production and transportation. Many of the highland Indians take what few products they have to market on the backs of their llamas (figure 1). The alpaca is used mainly for its extremely soft and fine fiber, although they also provide meat. The vicunas are smaller wild cousins of the alpaca and yield the most valuable animal fiber known to man.

Figure 1. Llamas, largest of the New World Camelidae have been used for centuries as the main beast of burden in the Andean countries of South America.

The management of the domestic camelidae has been extremely poor in the centuries of Christian influence since the arrival of the Spaniards in the Andean region. When Pizarro and his adventurers arrived in what is now Peru and Bolivia, they found vast numbers of llamas that were used by the natives for transport of local products. They also found an excellent cloth being made from alpaca fiber. The Incas had selection programs, which improved herd quality and a rotational grazing program to ensure the necessary forage. The management practices were lost when the Incan Empire was destroyed and have not yet been restored.

USU INTEREST

New interest has been kindled in these animals during the last several years. Some research has been conducted which provide preliminary information concerning their nutritional requirements, parasite control, and some reproductive processes. Research personnel at Utah State University became interested in the reproductive physiology of the llama through contact with Bolivian graduate students. We then visited Bolivia at the request of the Bolivian government and later through a Utah State University contract with the USAID program in Bolivia.

The opportunity to study the llama presented several interesting and unique situations. First, it was now possible to study animals on which very little controlled research had been conducted. Second, what information was available suggested that many of the reproductive processes and mating behavior patterns are unlike those of most other domestic animals.

Attempts were made to study several different reproductive processes including ovulation and ovarian functions and estrous cycle patterns, as well as male and female mating behavior and related management. Our research was conducted at Patacamaya Experiment Station located on the 13,000 to 14,000-feet-high altiplano about 60 miles north of the capital city of LaPaz.

BREEDING SEASON

A review of the available information on the breeding season of llamas in their natural environment indicated that it generally lasts from December through March. This is late spring and summer in the Southern hemisphere and coincides with the rainy season. During these seasons, feed is available in greatest abundance. It is interesting to note, however, that breeding can and does occur at other times of the year, both in the Andean areas and in other parts of the world. Studies of zoo records in England and South Africa have shown that llama births are equally distributed throughout the year. This demonstrates that breeding can take place at other times of the year both in their native habitat as well as in other parts of the world with widely varying environmental conditions.

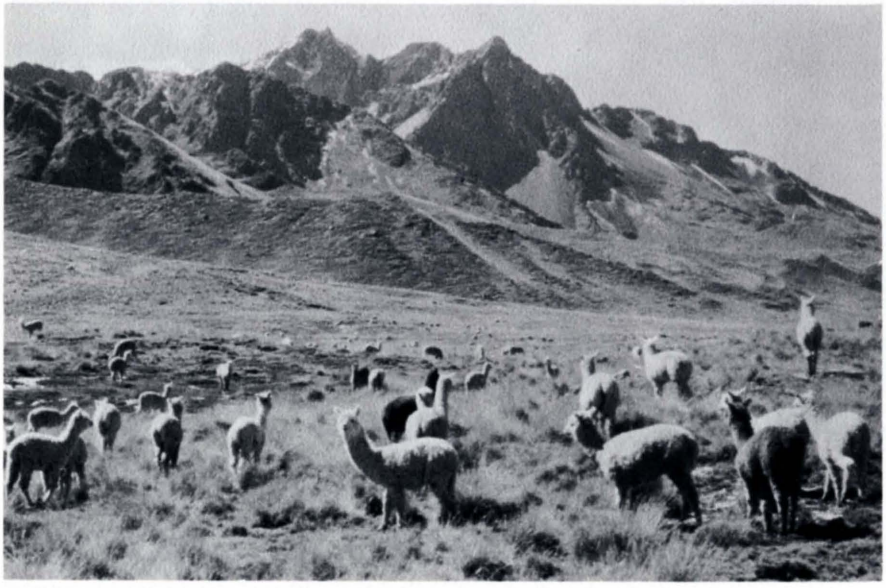

Figure 2. Alpacas, smaller editions of the llamas, yield meat and wool. Their fleece is finer, softer, and warmer than sheep's wool.

In the research we conducted, a study was made of mating behavior during the period from December to May (summer through late fall). It was interesting to note that two factors affected both the incidence of estrous and the degree of sexual receptivity of the female. First, when the female was first introduced to the male she showed almost continual sexual receptivity for at least 30 days and in a few cases for as long as 90 days. Following this initial period, however, the female became less and less receptive when exposed to the male each day.

Second, an environmental factor which affects female estrous behavior is associated with the season of year. As the year advances from February to May the female shows less and less estrous activity. We are uncertain as to what aspects of the environment associated with season of year are responsible for this change. It is unlikely that changes in light (light:dark ratio in the 24 hour day) is involved because Bolivia is near the equator.

Some mating activity has been noted at the Patacamaya Experiment Station in Bolivia during the months of June and July, which are supposedly the months of deepest anestrous (sexual quiescence). Attempts are being made to breed the Experiment Station herd during these months. It is possible that the established breeding season in the Andes may be determined more by management than by season-of-year influence on physiology. The conflicting evidence points out that

more information is needed to establish the influence of season of the year, free from the influence of management, on their reproductive processes.

OVULATION CONTROL

Contrary to the estrous behavior patterns just described for the llama most farm animals demonstrate regular estrous cycles during at least part of each year. In such farm animals, cycling or ovulation (shedding of eggs from the ovary) occurs, apparently spontaneously, at a time corresponding to the time of sexual receptivity whether mating occurs or not. Evidently such a phenomenon does not occur in the South American camels. Instead ovulation occurs naturally only as a result of the mating stimulus (copulation-induced ovulation). This same phenomenon exists in more familiar species such as the rabbit, cat, and mink. Results of our research have helped to establish the fact that these animals are copulation-induced ovulators. In addition, unlike most other species that exhibit this phenomenon, they will remate and reovulate after an approximate 2-week interim.

LOW MALE FERTILITY

We also investigated the low level of fertility in the male llamas. Mating behavior adds to the difficulty of collection of satisfactory semen samples. This seriously limits these types of studies. Sperm quality of the llama and alpaca is generally very poor and it is therefore important to determine the factors responsible and ways in which fertility can be improved.

Figure 3. Vicunas are the smallest of the South American camelidae and yield some of the softest wool known. In the wild state they have been decimated and are now protected by all the Andean governments. Pictured is a domestic vicuna — alpaca cross.

REPRODUCTIVE FACTORS

The reproductive rate in the llama is very low. It has been reported that as few as 5 to 20 percent of the females produce young each year. Obviously an increase in reproductive efficiency must be achieved before substantial gains of other economic characteristics can be made. Continued carefully planned and executed research is required to provide adequate answers to the many questions yet to be resolved. This type of research is badly needed and easily justified because of the prominent role these animals must surely continue to play in the development of much of the Andean economy. An understanding of the basic reproductive processes and their controlling mechanisms are prerequisite to improving the reproductive rate in these species.

A great deal of attention also needs to be given to improving the management of these animals since this has a direct influence on reproduction. Concurrently the nutrition of these animals must be improved, again with related management. Genetic improvement through selection and other breeding programs can then be achieved and management further upgraded.

Hopefully, these types of improvements in the New World Camelidae will help them to play their role in the improvement of animal agriculture which today is the backbone of the Andean economy.

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BREEDING BEES TO THE CROP

WILLIAM P. NYE and OTTO MACKENSEN

It is well known that honey bees visit blooming alfalfa (lucerne) more frequently for nectar than for pollen, and that when they collect the nectar, they pollinate only a small percentage of the flowers.

This behavior is the result of peculiarities of the alfalfa flower. It is largely self sterile and must be fertilized by pollen from other alfalfa plants. The anthers and stigma (the male and female parts) form a sexual column that is tightly enclosed by the petals. This column is suddenly released (or tripped) and strikes the bee on its head, leaving behind a mass of sticky pollen. When the bee visits another alfalfa blossom, the process is repeated and pollination results.

POLLEN COLLECTION

Perhaps honey bees find the action of the tripping mechanism disagreeable as many people have stated, but, more likely, they merely learn that they can obtain the nectar more rapidly without tripping the flower. At any rate, when seeking nectar, they soon learn to slip their tongues in from the side and avoid tripping the flower. Pollen collecting bees, however, trip nearly every flower, and hence are much more valuable to the alfalfa seed grower. Honey bees collect pollen and store it in the hives for food. When eaten by nurse bees, it supplies the basic ingredients for the production of the glandular substances used for rearing brood. Some of the pollen is also fed directly to the larval bees as they get older.

Since each species of plant has a distinctive type of pollen, beekeepers can tell what sources their bees are using by examining the pollen brought to the hives. They obtain this pollen by using traps which are essentially wire grids placed over the hive entrance. The screen allows the bees to enter but scrapes the pollen pellets from their hind legs.

Many beekeepers have observed that traps in some colonies yield more pollen than others and that not all traps at a location yield the same kinds of pollen even on the same day. It was thought that the foraging bees from different colonies become oriented to different areas where different plants grow. There was some scientific evidence to support this. It has also been observed that sharply different percentages of alfalfa pollen are often brought into hives placed side by side in an apiary. Although this indicated to us the possibility that a genetic basis for such differences exists, no effort was made to prove it until 1962. In that year 356 colonies from three sources were tested at Logan, Utah. Not enough pollen traps were available, so we modified a vacuum cleaner to pick up pollen-laden bees at the hive entrance and pull them into a killing bottle. From these, the percent that carried alfalfa pollen was determined. This worked well for a quick test of a large number of colonies.

Figure 1. Colony of honey bees on pollen trap. Note pollen in tray.

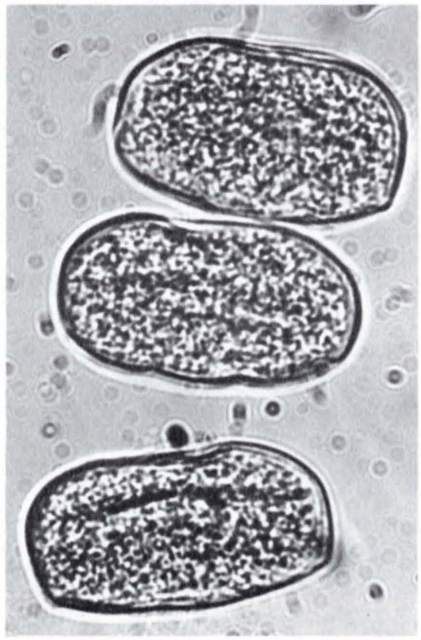

Figure 2. Alfalfa pollen grains. (unexpanded)

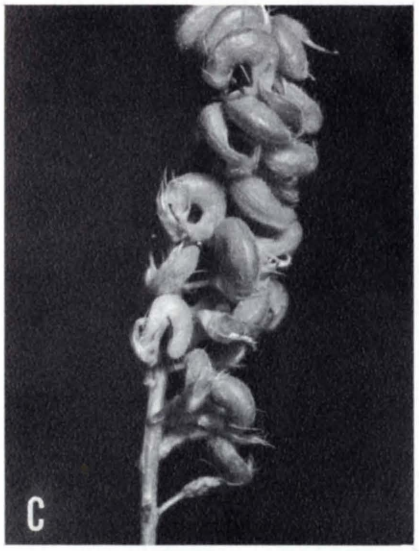

Figure 3. Photographs A to C show progress of a raceme pollinated by bees.

SELECTION FOR COLLECTION

Three high and three low alfalfa pollen collecting colonies were selected for the establishment of high and low preference lines. In 1963 virgin queens and drones reared from each of these selected colonies were mated to form six mating groups of sister queens. The tests showed that there was a greater similarity between colonies within mating groups than between less related colonies. This result indicated that the tendency to collect alfalfa pollen was an inherited characteristc and encouraged us to continue.

In bee breeding, the development of superior types is dependent on controlled mating of the queen. Ordinarily she mates with any drone that she encounters on her mating flight. An effective breeding program cannot be left to happenstance, so artificial insemination was used at Baton Rouge, Louisiana.

The breeding was done at the Baton Rouge laboratory because the season there is early enough for queens to be reared, mated and shipped to Logan in time to have worker progeny when alfalfa blooms. At Logan, the test colonies were placed in alfalfa fields grown for seed (alfalfa is not grown in the Baton Rouge area). In this way one generation a year was bred and tested.

LOW AND HIGH LINES

By the fifth generation, tested in 1966, the "low" and "high" lines had reached extreme levels of alfalfa preference. In that year the test colonies were placed first at Howell, Utah, on first crop alfalfa seed where other sources of pollen were scarce. Later they were moved to a second crop alfalfa field at Fielding, Utah, where other sources of pollen were plentiful and more comparable to those of previous years.

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Figure 4. Photographs D to F show what occurs when racemes are protected from bee — the flowers are not pollinated.

The percentage of alfalfa pollen collectors for the two locations combined were 85 for the high and 18 for the low preference lines. In 1963, early in the program, the best colonies had collected an average of only 40 percent alfalfa pollen.

At Howell, the high preference line colonies collected their pollen almost exclusively from alfalfa; the low preference line colonies collected about half of their pollen from other sources in spite of their scarcity. Thus the high line colonies had a greater number of pollen collectors returning to the hives than did the low line colonies. At Fielding, where other pollen sources were relatively abundant, the low-line colonies almost ignored alfalfa. Probably as a consequence, the low-line colonies had a greater number of pollen collectors at Fielding than did those of the high line.

These results, together with those from backcrosses of the hybrid to the inbred lines, in which a lot of breeding and technical study was involved, confirmed that alfalfa pollen collection was an inherited trait and dependent on many genes. Thus efforts to develop still better strains for alfalfa pollination could be fruitful.

As the pollen preference study proceeded, a number of problems developed. Inbreeding and selection for one quality caused some of the other desirable qualities to gradually disappear. Bees of the "high" line lost viability and vigor, and became restless and difficult to handle. Therefore, we had to breed out those bad qualities as we continued to select for alfalfa pollen preference. The present new bee strains appear identical to the ordinary bees, they are a little more nervous and aren't quite as prolific, but we don't think this is too serious at this stage of research.

ADVANTAGES

Alfalfa seed growers have long used alkali bees, *Noma melander* Cockerell, and alfalfa leaf-cutter bees, *Megahile rotundata* (Fab), (both pollen-collecting species) as pollinators. However, their management has entailed expenses that could be lowered appreciably if pollen-collecting honey bees were available. While we have mainly pursued the genetic and other scientific aspects, commercial breeders have been quick to realize the economic value of tailor-made honey bees for alfalfa pollination. For example, G. H. Cale, Jr., of Dadant and Sons, Hamilton, Illinois, and Charles B. Reed, President of Valley Pollination Service, Bakersfield, California, already have started work on selective breeding for alfalfa pollen collection based on our findings.

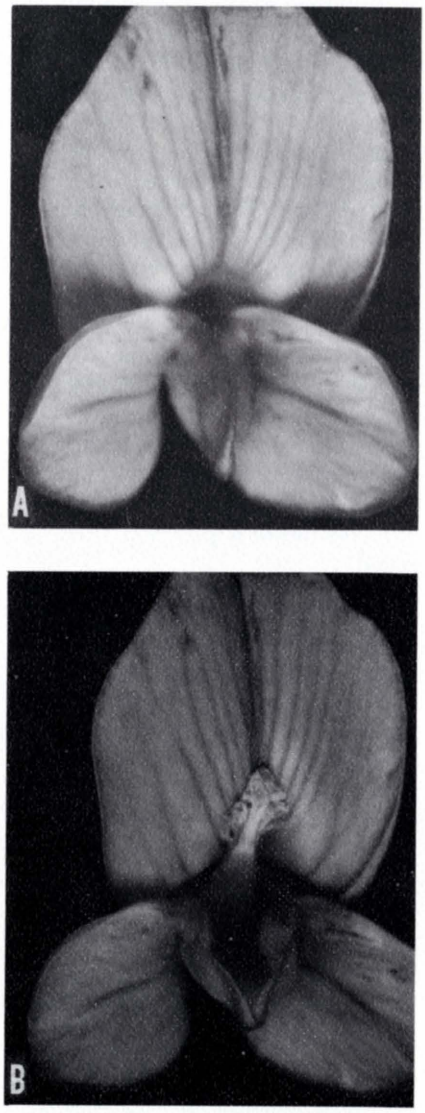

Figure 5. A shows untripped alfalfa flower while B shows a blossom that has been tripped.

About 90 crops grown in the United States are dependent on bees for pollination. To develop special pollinating strains for each of these is not practical. But a few crops are important enough and have a sufficiently difficult pollination problem to make the development of a practical strain worthwhile.

One such crop is red clover. There has been a lot of talk about the depth of the corolla tube of red clover. When honey bees are numerous on red clover, the seed yields are good. Our alfalfa experiment suggests that when bees are placed on red clover some of them will probably show a preference for its pollen. Beekeepers may have been led astray by too many references to the length of the corolla tube compared to that of the honey bee's tongue. Tube length is a factor only in nectar collection. The honey bee easily reaches red clover pollen when it wants to. Flowers of red clover are also self-sterile and require cross - pollination. Nectar - seeking bees have formerly been considered for red clover pollination but pollen seeking bees would be much better. If, as we suspect, the trait is present in certain colonies it need only to be ferreted out to develop a tailor-made honey bee for pollinating red clover.

RESEARCH CONTINUES

There is no clear evidence now that bees inherit a preference for any other pollen except alfalfa. Yet when pollen traps were placed on colonies in New Jersey cranberry bogs in 1966, one colony consistently collected almost pure cranberry pollen while others around it collected only a very small percentage of cranberry pollen. Selective breeding is being conducted among the descendents of this queen to determine if inheritance is involved. There is evidence that cotton benefits from honey bee visitation and a selective breeding program has been initiated. Laboratories of the Apiculture Research Branch in Beltsville, Maryland; Madison, Wiscon-

(Continued on page 60)

BIOCLIMATOLOGY - A PRACTICAL SCIENCE - - -

MAN - NATURE'S RECALCITRANT ANOMALY

E. ARLO RICHARDSON, LOIS M. COX, and GAYLEN L. ASHCROFT

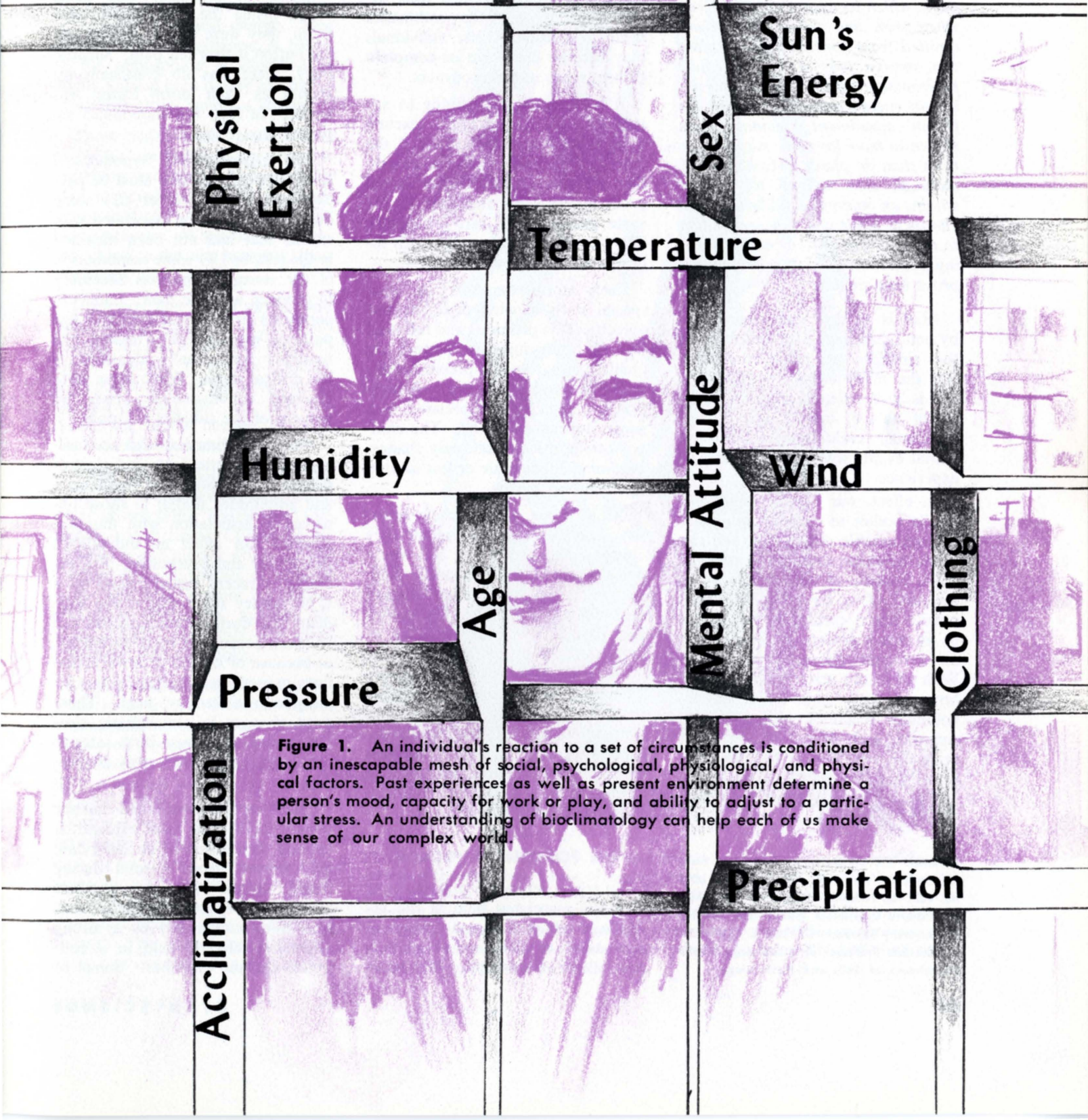

Figure 1. An individual's reaction to a set of circumstances is conditioned by an inescapable mesh of social, psychological, physiological, and physical factors. Past experiences as well as present environment determine a person's mood, capacity for work or play, and ability to adjust to a particular stress. An understanding of bioclimatology can help each of us make sense of our complex world.

The first article of this series defined Bioclimatology and showed its singular relevance to everyday life. The second installment explained why and how energy is the only factor common to virtually all natural and man-made phenomena. Energy exchanges thus supplied the unifying concept for the third installment, which focused on plants. Even when man and other animals are omitted from consideration, a plant can survive only if its immediate environment satisfies remarkably intricate energy requirements. In the fourth installment, animals were shown to have far more survival options than do plants. Most animals, although also obliged to operate within an energy equilibrium, can choose to move to a new area, adapt to the environment, or modify existing conditions if their surroundings prove inhospitable.

Man is as thoroughly enmeshed by nature's energy equilibriums as is the simplest one-celled organism. But the many convolutions of our brains give us unique abilities. In all of nature, only human beings consciously evaluate present and potential events with reference to past experience.

In effect, our brains permit our fragile bodies to conquer otherwise insurmountable difficulties. We can roam the ocean depths and seek the moon because of the sciences we've invented. Our fervent devotion to science-based technology has given us awesome powers, which fostered an arrogant disregard of nature. With all of our scientific know-how, however, we remain subject to involuntary reactions with our environment, and ultimately dependent upon the sun's energy for food, climate, and life itself.

●

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WEATHER AND HEALTH

Our involuntary responses to the sun's energy in the form of climate, are easily demonstrated by hypothesizing a simple storm system approaching Utah. As the storm, which represents an imbalance in atmospheric energy, moves into the state, some people notice their arthritis "acting up." Many asthmatics begin to wheeze. Other individuals may become depressed or complain of headaches and nervousness.

It is deceptively tempting to say that each of these people is reacting to the oncoming storm. But if the storm as an entity was the culprit, then a second, similar storm should produce the same reactions in the same people. This rarely happens. The storms and the people both incorporate too many variables.

Each storm develops its own special shifts in wind direction and velocity. It is preceded and followed by an individualized pattern of changes in barometric pressure, temperature, and humidity. Atmospheric electricity is associated with some, but not all storms. The composition of the air itself may change, becoming either more or less ionized as the storm passes.

All of these factors, their intensity, and the order in which they change, affect the degree and way a given person reacts to a storm. And, of course, the individual himself may differ drastically in physiology and psychology from one day or even one hour to the next. His diet, hormone-nerve interactions, his age, an excess or deficiency of one or more enzymes, his basal metabolism, and his sex, all influence the individual's physical and psychological status. In addition, his reactions always reflect the cultural and social pressures he has encountered.

THE SCIENTIFIC APPROACH

To try to define the precise cause of storm-associated pain in the arthritic, a group of known "reactors" were asked to spend some time in a controlled-climate room. The room was constructed so that each storm factor (temperature, humidity, and pressure) could be varied individually. Since people inside had no way of knowing what changes were taking place at any specific time, psychological influences were minimized if not eliminated.

When the arthritics were being tested inside the climate-controlled room, they were told to push a signal button if they felt pain. Surprisingly, there was no consistent response as each storm factor was varied. In fact, few individuals reported *any* reaction.

The experimenters hypothesized that: (1) the reaction must be psychological in nature, or (2) some other factor must be associated with storms that had not been included in the test, or (3) some combination of the storm factors was necessary to produce arthritic pain. Later experiments proved that the third hypothesis was correct. Pressure and humidity were finally identified as the critical items. When these were changed simultaneously, over 90 percent of the subjects felt pain.

Other experimental evidence indicates that electric fields and electromagnetic radiations (at frequencies and amplitudes similar to those observed in association with thunderstorms) can affect an individual's physiology and psychology. For example, a recent report issued by a U.N. agency states that traffic accidents rise during thunderstorms not so much because of road conditions, as because of slowed driver-reaction time caused by changes in the atmospheric electricity field. These same changes in atmospheric electricity may also cause birth rates to rise 11 percent, death rates 20 percent.

Other reports have noted that the thresholds of taste, odor perception, hearing, and touch in an individual may deviate from normal during thunderstorms. Similar variations have been reported by individuals who were surrounded by a strong alternating electric field in a controlled-climate chamber. Some of

the people also experienced unexpected pains in scars, and the pains continued for many hours after the individuals had left the electric field.

CLIMATE — HEALTH INTERACTIONS

Molecules of one or more of the gases composing the earth's atmosphere occasionally take on a positive or negative electrical charge. This process is called ionization. A parcel of the atmosphere is classified as highly ionized even if only one out of 20 trillion atoms carries a charge.

These negative and positive ions in the air are health factors. People breathing artificially de-ionized air tend to perspire, suffer from headaches, and often have an increased blood pressure. When negative ions are added to the air, however, their symptoms disappear.

Enclosure in a sort of oxygen tent filled with primarily negatively charged air has accelerated the healing of wounds. In burned patients, a preponderance of negative ions in the surrounding air not only increases the rate of healing, but lessens both infection and pain.

When positive ions predominate in the air, people develop headaches, nasal obstructions, hoarseness, sore throats and dizziness. Conditions associated with Chinook winds usually produce large quantities of positive ions. This may account for the increases in depression, suicides, asthma attacks, etc., that are often associated with Chinooks.

As the medical profession has become more aware of climate-health interactions, all sorts of correlations have been documented. For example, chemical substances administered to a healthy person may produce entirely different results under one set of weather or climatic conditions than under others. This observation is most important from a practical point of view because it suggests that a drug that is beneficial in one particular period, may be toxic in another. The same drug administered in one country or in one season

Figure 2. Arabs cope with extreme desert heat by wearing several layers of loose-fitting robes made of camel wool. Their robes absorb the energy from the sun and environment, and, although the surface temperatures become high, the numerous layers of cloth insulate the Arab's body from external sources of heat. The robes are kept very loose so that air can still circulate around the body to evaporate perspiration and thus eliminate excess metabolic heat.

of the year may cause entirely different reactions in the same person when given in a different country or a different season because of climatic variations.

Experiments with abnormally high dosages of digitalis have indicated that large amounts of this drug are considerably more toxic during severe storms than during good weather. The toxicities of large dosages of other drugs (such as atropine and morphine) are also known to be increased when it is stormy. In the future, both the physician who prescribes and the pharmacist who prepares drugs may have sufficient research information available to include the climate as a factor in determining the dosage, the method of preparation, and the form in which a drug is to be administered.

Various M.D.s in Utah are collecting data about the incidence of emphysema, tuberculosis, and other respiratory diseases and their relation to weather phenomena. Rheumatic fever is also of special interest to these doctors because this disease is more prevalent in Utah than in any other locale in the United States. Its particularly heavy occurrence in the state during winter and early spring seems to indicate correlation with the weather. U.S. Weather Bureau personnel have been working with some of the Utah doctors to help them determine what kind of data are needed to prove or disprove a weather-disease relationship for specific diseases.

NOT JUST INDIVIDUALS

Climate affects more than just our own personal sense of well-being. Through the ages, weather has exerted incredible influence over the affairs of men.

World-wide climatic data, as accumulated in the form of tree rings, have been correlated with historical events from 600 B.C. to modern times. The results tend to corroborate John Arbuthnot's 1733 observation that: "Governments are powerless to change the genius and temper of a race against the force of air and climate."

A professor of history at the University of Kansas recently concluded that differences in human behavior during warm and cold times and during climatic transitions were probably due to changes in energy levels. He noted that the major economic depressions were associated with excessive temperatures and drought. Economic booms usually came as rainfall increased. The so-called "Golden Ages," characterized by such things as good governments, extended learning, and rising production, have occurred almost invariably as the world moved from a cold to a warm cycle. Of 53 rulers who earned the title "The Great," 49 ruled during the cold to warm transition of the climatic cycle.

The professor further noted that democratic institutions always emerged and grew during cold phases. Cold periods have coincided since 600 B.C. with the formation of new leadership and a revival of good government. Then as temperatures returned to average, humanity reaped its "Golden Ages." If the professor is right, the cold period that the world is apparently now entering will see great civil wars followed eventually by a rejuvenation of democracies.

Our technology, however, may disrupt the professor's carefully chronicled historical relationships between climate and world trends. Long-lingering exhaust particles from rockets and supersonic planes are hypothesized as being able to alter the world climate. An umbrella of particles of one size could conceivably promote an ice age. If of another size, the particles might turn the earth into a much warmer place than it has been so far. The carbon in jet exhausts, when liberated by SST's in quantities at 70,000 to 80,000 feet, may catalyze and destroy the earth's protective ozone layer. It is ozone that currently keeps most of the sun's potentially murderous ultraviolet light from reaching the earth.

CLIMATE AND U.S. HISTORY

On a less comprehensive scale, climate has repeatedly helped shape the destinies of individual nations or groups.

In January 1777, while the troops of the continental army under George Washington were surrounded by the British at Trenton, the colonial cause seemed hopeless. Washington was unable to move his guns because of the thick mud caused by a combination of rain and early January thaw. During the night of January second, however, a heavy freeze enabled Washington to flank the British by taking his guns and meager supplies across the frozen mud to the safety of northern New Jersey.

The weather had previously aided the colonies in 1776 when the continental army was entrenched at Dorchester Heights outside of Boston. The location was easily defensible against ground troops but subject to defeat by bombardment from the harbor. For several weeks the British tried to bring the heavy guns of their warships to bear on the heights to dislodge the upstart revolutionaries. But an unprecedented period of heavy southerly gales prevented the ships from using their guns. The British finally evacuated Boston on March 17, 1776, defeated not so much by the colonists as by the weather.

The final blow to the British army was also climate-influenced and occurred on October 17, 1781. Cornwallis, while attempting to escape encirclement by crossing the York River, became the victim of an unexpected, violent storm. With his boats and men decisively dispersed by the storm. Cornwallis was forced to ask for the armistice that ended the Revolutionary War.

The weather has repeatedly influenced elements of U.S. history. For example, in 1847 as the Utah Pioneers gained their first view of the Valley of the Great Salt Lake, they were tired and discouraged. They had heard that it never rained in the valley during the summer time, and diaries of the time indicate that the desert looked decidedly uninviting. On the following afternoon

(July 24th), however, thundershowers developed and spread across almost the entire valley. This providential phenomenon generated a renewed determination in the pioneer band to "make the desert blossom as a rose."

The 1825-54 "potato famine" in Ireland had tremendous impact on the U.S. The famine was caused by a fungus disease known as late blight. This disease attacks potatoes only when summers are cold and wet. In fact, modern-day New Jersey researchers have reported that epidemics of potato blight tend to develop in the eastern U.S. whenever July temperatures are less than 73.7 F and rainfall exceeds 5.02 inches. When the July temperature is above this value and the precipitation less, blight will generally occur only 1 year out of ten. Apparently weather in Ireland during the second quarter of the 19th century was highly conducive to blight development. Thus Ireland's climate was indirectly responsible for giving the U.S. much of the manpower (approximately 2 million people) needed to push back the western frontier.

The Los Angeles Watts District incident, the Newark, New Jersey explosion of last year, the riots forecast for 1968 — all attest to man's response to weather. In the case of riots, research has finally gotten around to proving what common sense had "known" for sometime. Heat, plus the crowding of people who have learned to accept violence as commonplace, equates with a high riot potential. Proof for this now routinely accepted "fact" came from Kansas research.

When the research subjects were high school dropouts, parolees, and juvenile delinquents, high temperatures combined with an area per person of 6 square feet produced continual arguing, fist fights, threats, and even an attempted knifing. Lower temperatures or smaller groups produced far less evidence of aggressive behavior.

When the experiment was done with university graduate students, however, the results were different. Even with the highest temperatures and most severe crowding, no aggressiveness was observed. Apparently, violence must be the habitual solution to problems before it will appear under heat-crowding stress.

HARNESSING TECHNOLOGY

Recent years have been incredibly productive of technological progress on virtually all fronts, including bioclimatology. In some cases the inventions or techniques seem likely to destroy all of mankind. But in others they have been used to gain insights into man's rightful place in nature.

For example, recognition of the existence of atmospheric jet streams during World War II provided climatologists with an unprecedented tool for learning about the mechanics of the atmosphere. Since atmospheric circulation also determines the way storm systems are distributed around the world, the status of the jet streams is indicative of the way storms are going to develop and move.

The discontinuity of the jet streams is now known to be a factor in setting boundaries for areas of heavy or light precipitation, and in the weakening or intensifying of frontal systems. As meteorologists learn more about "reading" the jet streams, they hope to achieve better accuracy in judging the relative stability of upper-level, low-

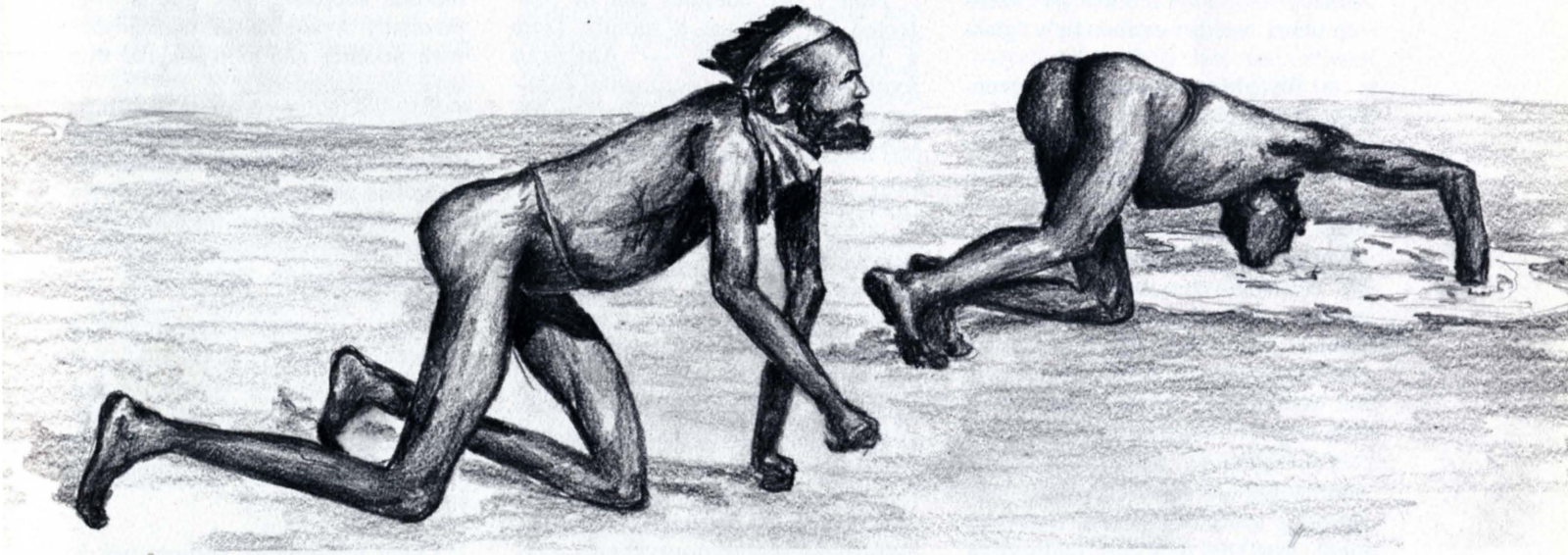

Figure 3. Few modern men could survive as Australian Aborigines. An Aborigine is content to use whatever food the land provides, whether it is worms, ants, kangaroos, shrubs, or rodents. He can and will run for hours to intercept a precious rainsquall so he can suck up some water before it disappears into the perennially parched earth. The energy balance between the Aborigine and nature is conspicuously precarious. That between modern man and nature, however, is equally precarious; it is merely less obvious because of civilization's intervening veneer.

pressure systems and in determining the amount of turbulence in the atmosphere.

One of the favorite winter routes for the temperate zone jet stream is in the vicinity of Utah. As these twisting tongues of high speed wind whip across the state, storms may intensify or clouds dissipate in perverse contradiction of carefully calculated weather forecasts. It is in the winter, therefore, that Utah meteorologists most often have to renew their ulcer prescriptions.

Another natural phenomena has actually come under man's control because of research begun in Utah in December, 1946. While working as an avalanche patrolman at Alta in 1946, Montgomery Atwater participated in an attempt to find a boy buried by an avalanche. After that experience, Mr. Atwater dedicated himself to learning how to make sure ahead of time that a given slope was safe for skiers.

A great deal had already been done (primarily in Europe) to define the mechanics of these massive snow slides. For example, it was known that avalanches almost always run on the same slopes every year. They also usually start at the same place. This tendency towards repitition was an avalanche's "glass jaw."

At first, Mr. Atwater took advantage of this characteristic by using a two-man team to trigger an avalanche before its natural time. But the dangers to the men doing such work were too great to be condoned indefinitely. Then during the winter of 1951-52, the Atwater crusade against avalanches took a new turn. Instead of pitting men's personal skills and know-how against nature, the avalanche "trigger-men" were able to begin using artillery.

The 1951-52 winter deposited 600 inches of snow at Alta. The resulting avalanche potential was so great that the previous method of skiing over the critical point of a slope to start each one became impractical. But by using a cannon as a starter mechanism, the avalanche patrols were able to keep the dangers minimized despite the tremendous snow depth.

The 1960 Olympics at Squaw Valley saw the introduction of the recoilless rifle as a patrolman's standard equipment. These rifles and permanently installed artillery are still the accepted weapons against avalanche danger, though rockets are used in special cases.

Thus avalanches have come under man's control, at least in areas popular with skiers. But away from the charted and patrolled slopes, the unwary may still be engulfed by cascading snow.

REASON TEMPERED WITH RESPONSIBILITY

Man's ingenuity in manipulating his physical surroundings seems far from exhaustion. But we may do well to slacken our headlong and often myopic pursuit of technological "progress." We've already proved that "we can" does not necessarily equate with "we should."

We are taxing our bodies and our minds in ways that they are not equipped to meet. Air, water, and noise pollution of our environment are real and growing problems because we've blithely ignored too many energy equilibriums for too many years. Our bodies and our brains give us remarkable versatility, but each has inherent limitations that we can no longer ignore with impunity.

The next and final installment of this series will describe ways that each of us can modify his local bioclimatology. Attention will also be given to our responsibilities towards the other members of our bioclimatological whole.

FUMIGATION PREVENTS FOULBROOD RECURRANCE IN HONEY BEES

Honey bee colonies can be protected for at least 8 months from a bacterial disease — American foulbrood — by experimental fumigation treatments being tested by the U.S. Department of Agriculture.

Microbiologist Hachiro Shimanuki of USDA's Agricultural Research Service at Beltsville, Md., fumigated beehive equipment with ethylene oxide, a gas often used by hospitals and food processors to sterilize heat-sensitive materials. Bees in hives to which untreated equipment was added developed foulbrood within two weeks.

Best results occurred when Mr. Shimanuki placed four supers (removable upper stories of beehives) with brood combs on a plywood board, covered them with a plastic cloth, and then fumigated them with ethlene oxide obtained from a commercial supplier. The gas is commercially available in combination with another gas to make the mixture nonflammable.

After fumigating the supers were sealed under the plastic for 26 hours. Residues that might be harmful to bees were dissipated by holding the supers for an additional 24 hours in a room heated to 106 F.

Before recommending treatments to beekeepers, Mr. Shimanuki plans additional tests to establish the best amount of gas to use and to determine optimum temperatures, humidity, and other favorable fumigating conditions.

Other preliminary findings will be studied further. For example, the treatments show promise for controlling other bee diseases as well as the greater wax moth, which can ruin colonies.

What is the value of Utah's deer hunting resource?

E. BOYD WENNERGREN

Finding the value of Utah's outdoor recreation is an important but difficult task. It is difficult because most forms of outdoor recreation occur on public land and water resources and are not "bought and sold" in the conventional marketing process. It is important because public administrators charged with the responsibility for developing recreation facilities need estimates of value before committing money and resources to program development. Furthermore, the rapidly increasing demand for recreation services resulting from such factors as increased leisure time, incomes, and population necessitates continuing adjustments in resource allocations among alternative uses. In addition this demand intensifies the need for such enlightened decision-making.

The absence of a market mechanism makes it necessary to estimate the value of resources by finding how much consumers are willing to pay to enjoy a particular resource. A market-pricing system can then be simulated and adapted to conventional valuation procedures.

Problems of recreational resource valuation have been investigated by economists at Utah State University for several years. An earlier article published September 1964 in *Utah Science,* "Valuing Resources Used in Recreation," reported an analytical model developed for valuing water used in boating recreation. The present article reports the use of that same model to estimate the statistical demand and value of Utah's deer hunting resource.

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TWO PREMISES

Two premises are useful to an understanding of the demand and valuation procedures. First, outdoor recreation is a consumable good, capable of satisfying human needs and wants. It is primarily an aesthetic experience or product—a fact which does not disqualify it from conventional economic analysis. Any distinctions between the aesthetic qualities of more conventional type commodities and recreation are likely more imaginary than real. Second, outdoor recreation is not a costless commodity even if formal market-oriented costs are not assessed. Users incur variable costs such as travel costs and other on-site expenditures which serve to regulate the amount of activity. Furthermore, recreation activities must compete with other consumptive items for the limited time and money of individual users. The presence of variable use costs, likewise, serves as a useful substitute in the absence of conventional market prices for outdoor recreation. Where market prices serve as one type of consumption regulator for items subject to the market place, variable use costs serve a similar function for non-market priced commodities.

VALUE ESTIMATING TECHNIQUES

Because a formal pricing mechanism is lacking other techniques must be used to estimate values. Several techniques have been employed to approximate recreational resource values. Among the more common have been (1) estimates based on recreationists' gross expenditures, (2) the value added to the economy by recreationist expenditures, and (3) the costs of developing, operating, and maintaining a particular recreation site. Of these, the gross expenditure method may be of particular interest since it was applied to Utah recreation in a 1957 study. The 1957 study revealed that Utah recreationists spent about $40 million annually of which approximately $15 million was associated with deer hunting. The implicit conclusion was that Utah's deer hunting activities and, consequently, the resources are worth this much.

The basic rationalization underlying the gross expenditure technique

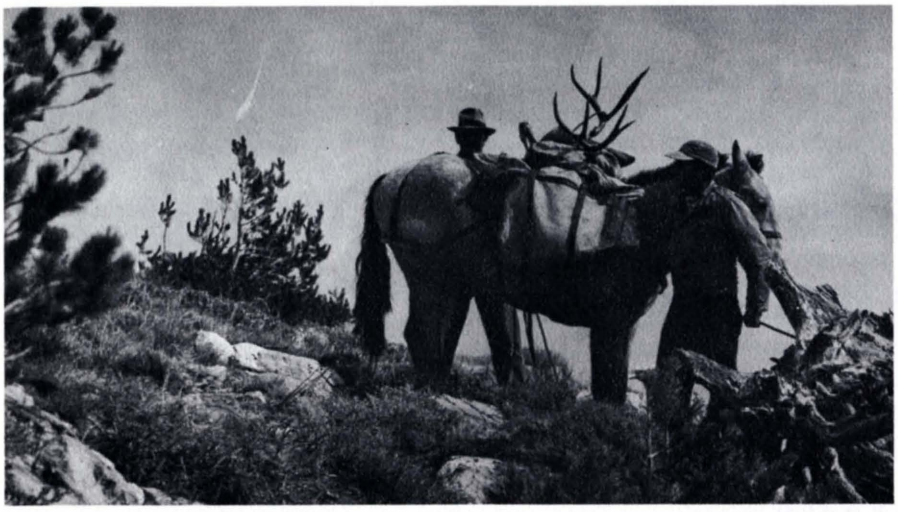

Figure 1. The high mountain areas contribute one of their resources during the hunting season.

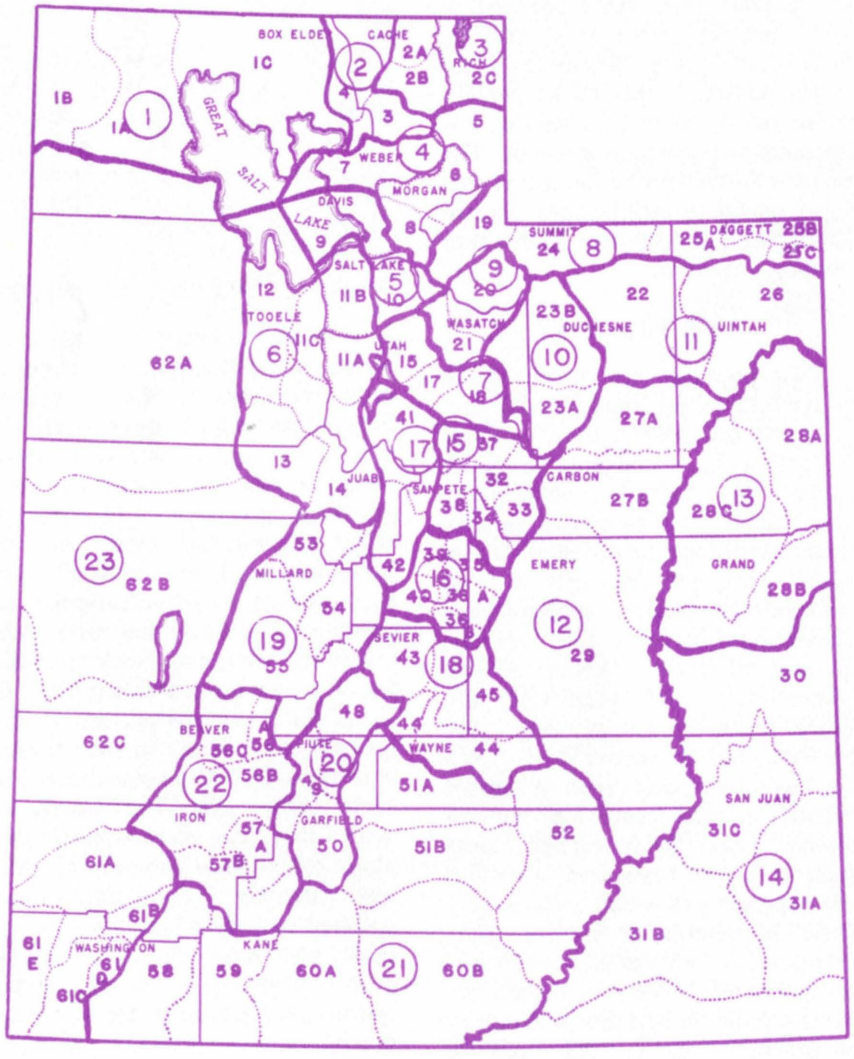

Figure 2. The areas from which hunting data was gathered for this study.

of imputing resource use values is that the recreation is worth at least as much as the recreationist spends or else the recreationist would not make the expenditure. This rational appears to have validity, but it promotes fallacious and illogical conclusions. While it may be true that deer hunting to an individual or a collective group is valued at least as high as the money spent to engage in hunting, it is also true that if the hunting activity were somehow abolished the money previously used for hunting would likely be used to purchase other items or activities. This means that if hunters were forced to select other alternatives for their money and time resources, neither the loss suffered nor their valuation of hunting would be reflected in the amount of their total expenditures on hunting. Rather, their loss and hunting value would be reflected in some measure not directly revealed by the total expenditures. The use of gross expenditure estimates is popular because of the size of the estimates normally generated. But a comparison of total expenditures for various resource uses or industries (as is often done) is not usually meaningful. To argue that two resource uses are equally valued because people spend equal amounts of money in these uses overlooks the fact that the net values received may be entirely different. Expenditures of equal amounts may rightly imply that consumers making the expenditures are realizing equal gross values from the two uses (since value received must at least equal the expenditure), but the net values received may vary considerably. To impute resource values on the basis of gross expenditures is akin to valuing farm land on the basis of the total expenses necessary to operate the land. No wise farmer values land on the basis of total expenses. Farm values are normally based on *net returns* obtainable from the land. It is only logical that recreational resource values, likewise, are properly assessed when valued on the basis of net values to recreationists.

The logical difficulties associated with valuing resources from measures of gross expenditures are likewise apparent in applying the other two methods mentioned. All fail to derive a measure of net value resulting from resource use.

ANOTHER TECHNIQUE

Another technique which has been proposed for valuing resources is the *consumer surplus* approach. Consumer surplus is an economic concept which relates what consumers actually expend for a commodity to those which they would be willing to expend for the item rather than go without. As an early economist, Alfred Marshall, observed:

> "We have already seen that the price which a person pays for a thing can never exceed, and seldom comes up to that which he would be willing to pay rather than go without it; so that the satisfaction which he gets from its purchase generally exceeds that which he gives up in paying away its price; and he then derives from the purchase a surplus of satisfaction. The excess of the price he would be willing to pay rather than go without the thing, over that which he actually does pay, is the economic measure of this surplus satisfaction. It may be called **"consumer surplus."**

It can be seen from the definition that the surplus concept as applied to hunting recreation purports to measure a value received by hunters which is additional to that which they actually pay. The value accrues because hunters pay less (in the form of expenditures) for the hunting activity than they would be willing to pay. The willingness to pay is determined by their demand schedule for hunting. The demand is defined as a schedule of quantities of hunting activity hunters would take at various prices (or costs). While some quantity of hunting would be demanded at several cost levels, only one of the cost levels is relevant for a given season because this is the hunter's actual cost. As a consequence, a difference arises between the current cost level and the other levels at which hunting would be demanded. It is the variation between these costs which is the basis for the surplus.

Table 1. Estimates of demand and coefficients of determination for 23 hunting areas in Utah, regular hunt, Utah, 1965

Area	Estimating formulas	Coefficient of determination r^2	Number of observations
1	3.85 X - 2.21	.34*	12
2	8.16 X - 4.16	.91‡	25
3	.81 X - .930	.74‡	16
4	1.15 X - .862	.63‡	29
5	.55 X - 2.26	.92‡	19
6	3.67 X - 2.85	.96‡	34
7	.79 X - .706	.28‡	39
8	9.74 X - 2.04	.64‡	44
9	4.75 X - 1.68	.79‡	32
10	28.25 X - 2.30	.62‡	41
11	2.15 X - 1.01	.86‡	15
12	12.72 X - 2.09	.73‡	19
13	11.49 X - 1.63	.64‡	19
14	3.50 X - .866	.81‡	23
15	9.58 X - 2.15	.73‡	48
16	3.06 X - 1.78	.99‡	20
17	2.85 X - 1.59	.81‡	28
18	3.93 X - 1.47	.59‡	23
19	421.09 X - 4.47	.90‡	22
20	64.01 X - 3.76	.91‡	15
21	3.01 X - .934	.75‡	23
22	3.18 X - 1.25	.49‡	15
23	2.18 X - 1.17	.98‡	17

* Significant at the 5 percent level of probability.
‡ Significant at the 1 percent level of probability.

Table 2. Estimates of demand and coefficients of determination for 23 hunting areas in Utah, archery hunt, Utah, 1965

Area	Estimating formulas	Coefficient of determination r^2	Number of observations
1	2.64 X - 1.37	.78‡	6
2	5.37 X - 1.84	.84‡	21
3	.981X - .896	.74‡	14
4	24.29 X - 3.35	.32*	14
5	1.78 X - 1.33	.76‡	17
6	2.50 X - 1.46	.72‡	28
7	1.36 X - 1.27	.73‡	26
8	2.69 X - 1.04	.37‡	39
9	4.30 X - 1.18	.65‡	14
10	28,254.84 X	.36‡	27
11	13.96 X - 1.30	.89‡	13
12	13.78 X - 1.42	.88‡	11
13	29,123.82 X - 3.69	.82‡	27
14	167.62 X - 2.14	.99‡	8
15	317.33 X - 3.80	.95‡	55
16	4,379.45 X - 4.74	.74‡	32
17	18.49 X - 2.48	.98‡	18
18	1,781.00 X - 3.55	.65‡	25
19	27,366.62 X - 4.56	.96‡	17
20	3.14 X - 9.49	.64‡	21
21	1,333.63 X - 3.73	.97‡	15
22	89.49 X - 2.21	.99‡	19
23	2,334.01 X - 5.80	.96‡	8

* Significant at the 5 percent level of probability.
‡ Significant at the 1 percent level of probability.

One point should be kept in mind. While the magnitude of the surplus value is expressed in monetary terms, the value is not involved in exchange and, therefore, does not directly influence the economic well-being of the individual or the region. It is only a monetary expression of the value extracted by hunters additional to their costs of participation.

THE STUDY

Estimates of deer hunting values for resident deer hunting in Utah were made for the 1965 hunting season by using the consumer surplus concept. Separate estimates were made for the archery and regular rifle hunts. Data were obtained from a sample of about 5,000 regular hunters and 2,000 archery hunters. Information was gathered on variable trip expenditures, numbers of trips to each herd unit, and hunter cities of origin. Variable trip expenditures included such items as travel cost, ammunition expended, rented lodging, and additional variable camp costs. Because of the sparseness of data for some herd units, certain units were grouped in consultation with the Utah Fish and Game Department. A total of 23 hunting areas were designated. These are shown in figure 1.

ESTIMATES OF DEMAND AND RESOURCE VALUES

From the data collected, statistical estimates of demand were made. The demand equation was of the form: $Y = AX^b$

where: Y = average number of trips per hunter per season

X = average travel and on site costs per trip

The statistical demand estimating formulas for the 23 areas are shown in table 1 for the regular hunt and table 2 for the archery hunt.

The coefficients of determination (r^2) indicate the percentage of variability in average numbers of trips to a particular area that is explained by variations in average travel and on-site costs. All except two of the relationships were statistically significant at the 1-percent level of probability. Most of the exponents in the demand equations had absolute numerical values greater than 1.0 which suggests that hunter trips to these areas are responsive to variations in use costs. Furthermore, it signifies that these areas have reasonably good substitute areas.

The demand equations serve as the basis for calculating the *consumer surplus* value as an indication of user value of the hunting and consequently the resource values. Hunting area 13 is used to illustrate the calculation and logic of the estimate.

Given the demand equation for area 13, the average number of trips per licensed hunter can be calculated (column 3, table 3). Each line in table 3 represents the calculations for hunters from a given city of origin who visited area 13. Column 1 shows the round trip distance. Column 2 is the average travel and on-site costs incurred by hunters from the origin. Column 4 gives the total value received by an average hunter who visited the area and is estimated by the mathematical integral of the demand equation is assumed to express the individual hunter's desire and utility for the area.

Table 3. Estimate of annual surplus value for hunting area 13, regular hunt, Utah 1965

Round trip distance (miles) (1)	Average travel & on-site costs/trip (dollars) (2)	Average trips license holder * (3)	Total value/ license holder (dollars) (4)	Total cost/ license holder (dollars) (5)	Surplus value/ license holder (dollars) (6)	License holders at origin (7)	Total surplus value (dollars) (8)
176	8.83	.330	5.54	2.92	2.62	1,777	4,661
156	9.33	.302	5.28	2.82	2.46	2,876	7,089
184	10.20	.261	4.88	2.66	2.22	415	922
280	15.00	.139	3.40	2.09	1.31	1,897	2,485
308	16.40	.120	3.10	1.97	1.13	977	1,103
433	21.65	.076	2.28	1.65	.63	6,455	4,043
432	21.80	.076	2.26	1.65	.61	3,864	2,376
443	22.15	.074	2.22	1.63	.59	1,831	2,275
445	22.25	.074	2.22	1.63	.59	3,864	1,078
448	23.90	.065	2.02	1.55	.47	1,807	845
511	25.55	.058	1.86	1.49	.37	3,574	1,308
463	25.65	.058	1.85	1.49	.36	39,010	14,047
522	26.50	.055	1.77	1.46	.31	39,010	12,174
516	27.36	.052	1.69	1.42	.27	39,010	10,375
540	27.50	.052	1.68	1.42	.26	13,984	3,617
559	28.95	.048	1.57	1.38	.19	892	167
597	29.90	.045	1.49	1.35	.14	13,984	1,994
548	33.15	.038	1.34	1.27	.07	972	7
567	33.35	.038	1.26	1.26	.00	2,303	0
					TOTAL		70,566

* Calculated from regression equation: $Y = 11.49 x - 1.63$.

It can be seen that this total value decreases as the cost per trip increases. Column 5 is the actual total cost incurred by a hunter and is calculated by multiplying the cost per trip by the number of trips (columns 3 and 4). Column 6 is the net value additional to the actual costs received by an average hunter from each origin visiting area 13. This is the *consumer surplus*. The total surplus received by all hunters from a given origin (column 8) is derived from the average individual surplus multiplied by the number of hunters. For area 13, the total for all origins is $70,566 for the 1965 hunting season.

An examination of the date in table 3 reveals certain things about the valuation procedure. First, the costs of use are important to the value estimate, but the estimate as reflected in the consumer surplus is additional to these use costs. Secondly, the surplus realized by hunters using the area decreases as their costs of use increase. This means that values derived from lower cost sites (usually closer to home) are greater than for higher cost sites; a situation which seems logical. Finally, the total value incorporates the effect of the total number of hunters. Consequently, origins of higher cost may contribute great amounts to the total value not because the individual surplus is high but because of the larger number of hunters who reside at the origins.

The procedure explained for area 13 was used to calculate estimates for each of the 23 areas in Utah. These are summarized in table 4 for the archery and regular hunts. The total value for the 1965 hunting season is $2,602,194 of which $2,308,020 is associated with the regular hunt. The highest single value was related to area 14, $327,-550. Area 1 yielded the smallest value.

To reiterate the logic of the estimate, the $2,602,194 is an estimate of the value hunters received during the 1965 hunting season additional to their variable costs of use. Since the net value is extracted by consumers it is imputed to the resources as an estimate of the resource value.

Table 4. Estimated surplus value of hunting resources for 23 areas in Utah, archery hunt and regular hunt, Utah 1965

Area	Archery hunt estimated surplus (dollars)	Regular hunt estimated surplus (dollars)	Total estimated surplus (dollars)
1	1,202	12,358	13,560
2	5,663	8,162	13,825
3	8,222	33,494	41,716
4	8,305	189,311	197,616
5	12,927	26,176	38,003
6	17,309	36,376	53,685
7	11,255	230,024	241,276
8	65,790	156,164	221,954
9	19,140	222,357	241,767
10	5,337	177,415	182,752
11	23,379	105,790	129,169
12	15,362	46,143	61,505
13	12,761	70,566	83,327
14	14,761	312,789	327,550
15	4,525	104,437	108,982
16	1,799	24,047	25,846
17	4,764	75,528	80,292
18	6,759	60,336	67,095
19	2,479	10,076	12,555
20	22,224	11,365	38,599
21	4,550	214,285	219,375
22	18,201	65,172	83,373
23	7,290	116,235	123,525
Total	294,724	2,308,606	2,607,347

DERMESTID BEETLES CAN CARRY SALMONELLA

Research entomologists have learned that the dermestid beetle, *Dermestes maculatus*, can be a carrier of *Salmonella*.

Salmonella is a genus of bacteria frequently associated with various types of food poisoning, with acute gastrointestinal inflammation. Despite elaborate precautions taken by industry, it appears sporadically in processed foods and feeds.

In testing beetles collected at one location, it was determined that crushed larvae placed on a culture medium were all positive for *Salmonella*. Adult beetles found infected externally were cleansed on the outside and on testing were found to carry an internal infection also.

Agricultural Research Service entomologists speculate that in a plant infested with these beetles it would be possible for the insects to carry the *Salmonella* organism from infected areas into clean areas, including holding or packer bins, and so infect products that had earlier been pasteurized or sterilized. It has previously been established that rats, birds, and even humans can be vectors of *Salmonella* organisms.

WE EAT MORE MEAT

Twenty years ago 145 million americans spent more than 6 percent of their disposable (after-tax) income for an average of 145 pounds of beef, veal, pork, and lamb per person per year, or a total of more than 21 billion pounds of meat.

Today, 198 million americans spend less than 5 percent of their disposable income for an average of 174 pounds of beef, veal, pork and lamb, or a total of more than 33 billion pounds of meat.

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GRAZING VS. WHEAT PRODUCTION

(Continued from page 33)
reported which furnish information concerning the size of wheat-producing and forage-producing enterprises necessary to justify investment in the factors of production.

Table 2. Wheat production costs, returns, and investment (per acre)

Per acre costs		
Seed (.64 bu. @ $1.97)	$ 1.26	
2,4-D (.25 lb. @ $1.19)	.30	
Hail insurance	.62	
Interest on operating capital	.15	
Machine operation and repairs	7.77	
Total variable cash costs	9.10	
Operator labor (2.05 hr. @ $1.50)	3.08	
Total variable implicit costs	3.08	
Total variable costs		$12.18
Taxes	3.20	
Total fixed cash costs	3.20	
Depreciation on fences and storage buildings (20 year)	.21	
Depreciation on machinery (5 yrs. 10% salvage)	5.22	
Interest on investment (5%)	7.69	
Total fixed implicit costs	13.12	
Total fixed costs		16.32
Total per acre costs		28.50
Per Acre returns (11 bu. wheat @ $1.84 - 1967 prices		20.24
Net return (pure economic return)		− 8.26
Net return to capital		− .57
Net return to capital and operator labor		2.51
Net return to implicit costs (capital, operator labor, depreciation)		7.94
Per acre investment		
Land 60.00 x 2[1]	120.00	
Machinery	29.00	
Storage buildings and fences	4.40	
Total per acre investment	$153.40	

[1] One-half the farmland is planted to wheat and one-half summer fallowed.

BREEDING BEES

(Continued from page 48)
sin; and Tucson, Arizona, are involved in these programs.

Positive results in these new programs would show that preference of individual lines for specific sources of pollen may not be unusual, and that it should be possible to "tailor-make" honey bees for the pollination of many kinds of crops.

Figure 6. Nectar-collecting honey bee working a flower from the side to avoid tripping the flower.

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